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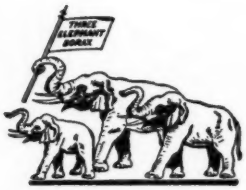

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R. H. STINCHFIELD, *Editor*

Editorial Office: 1155 16th Street, N. W., Washington 6, D. C.

VOLUME XXVIII NO. 7

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THERE USUALLY IS A REPAIR JOB AFTER THRESHERS LEAVE.

Better Crops with PLANT FOOD

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We Can't Do Business With—

BUGS

Jeff McDermid

CRAWLING recollections arise as I peruse a progress report of scientific quests for insect extinction. These wriggling memories remind me that it is quite within the span of my lifetime that economic entomology has provided mankind with something tangible in his constant itching struggle against voracious bugs and devouring worms.

If victory gardeners and all other amateur planters of esculent herbs and succulent berries had nothing more effective to ward off pests than the countryside possessed forty years ago, we would have no quarrel to pick with the WPB about the scarcity of pressure cookers or tin containers.

Indeed were we as short of insect ammunition as we found ourselves in my leg-bitten youth, it would be just as heroic and eventful to raise a mess of beans as it is to drop a brace of bombs.

With plant culture rendered more foolproof and certain, it permits our untrained operators to coax along a fair harvest so that others of bravery, ingenuity, and keen persistence may be drafted into warfare with those larger, uglier, more dangerous "insects" now due violent extermination.

Shooing at screen doors and tortured cows with paper flappers, laying sticky papers around for flies and babies to tangle with, filling poison plates with dope for invading ants, and squirting kerosene along the cracks of ancient bedsteads—these comprised our simple system of household pest control. As soon as we crossed the threshold to the outdoor jungles of teeming predatory

marauders our futile barricades were abandoned, and all we could hope for there was a little help from birds and chickens.

So dependent were we upon the random notions of birds to pick up meals among our enemies that our schoolhouse debates often dragged interminably between those who wanted to kill all the crows and blackbirds on sight, and others who cried loudly for their protection because their gizzards often held carcasses of plant destroyers.

I MUST have been raised among bugs and worms, for some of my first observations concerned the antics of ants, the bumbling efforts of tumblebugs rolling along their dung balls, the creeping carpet cricket, the leaping grasshopper, the noxious smelling stinkbug under my hand, the sprawling daddy-long-legs on the door post, the fuzzy brown caterpillar at my feet, and the dainty spotted ladybug that my mother said was needed suddenly at home, owing to the fact that her domicile was afire. And sometimes when we moved to new quarters without previous fumigation and scouring, I woke up with swollen spots not caused by mosquitoes altogether.

When old enough to tackle the hoe or lead the horse afield, I became acquainted with other divisions and army corps in the insect world. Bird-pecking and finger-picking processes or maybe foot-mashing were the mainstays in our hopeless campaigns. We coaxed one particular old rooster and his harem of hens to follow our cultivator. All of these at best were but the feeble beginnings of organized economic entomology.

From notations recently seen, I am informed that the first regular systematic courses in ways to know insects and combat them were taught at Kansas State and Michigan State Agricultural Colleges back in 1867. I am not sure that folks had got along so far in their language as to dub them courses in "economic entomology"—a name that stumped me hard when I first saw it in a college catalog.

Three years after these courses were started, a modest treatise on agriculture was written by a city editor in New York City, including a nifty preface of explanation and apology for such a topic from a cave dweller in Gotham.

Its author was about as widely known then as our Mr. McCormick of the *Chicago Tribune,* and just about as unrelenting in his attitudes. In the middle of this book, which was dedicated to any man who could invent a power plow capable of turning twelve acres a day, the author inserted a chapter on insects. Now he therein invaded a field wherein he was an authority, being one of the big bug-smashers of his time. Not to keep up the suspense too long, I refer to Horace Greeley. Laying aside his faded umbrella, he divested himself of these remarks anent insects as crop pests:

"I would be far below the mark if I were to estimate the average loss of the farmers of this country from insects at one hundred million dollars per annum. In my neighborhood the peach once flourished, but does so no more, and cherries have been all but annihilated. Apples were till lately our best crop, but worms take half of them and sadly damage what they do not destroy. Plums we have ceased to grow; pears are stung or blighted; even the currant has its insect enemy.

"We must fight these paltry adversaries more effectively or allow them to drive us wholly from the field. In this I have no doubt that the best allies in this inglorious warfare are the birds. They will save us if we do not destroy them. Whenever clouds of birds shall habitually darken our fields in May and less notably through the summer months, we may reasonably hope to grow fair crops of our favorite fruits."

But at this point Editor Greeley broaches another line in pest control:

"I hold that the multiplication of insects and their devastations are largely incited by the degeneracy of our plants caused by the badness of our

culture. I presume that wheat and other crops could be devastated by insects if there were no slovenly, niggard, exhausting tillage methods used. But when the fields of western New York were first tilled there were few insects; but after crops of wheat had been taken from those fields until they had been well-nigh exhausted of crop-forming elements, we began to hear of the desolation wrought by insects. I believe that we should have heard little of insects there had wheat been grown on

those farms but one year in three since their redemption from the forests.

"But whatever might have been, the Philistines are upon us, and we are doomed for at least a generation to wage a relentless war against insects, multiplied beyond reason by the neglect of our predecessors."

THAT Greeley was right in surmising that failing soils and woeful neglect of clean culture and sanitation helped to give those ancestors of our present pests a secure and threatening foothold, I need only quote from a treatise on orchard and garden insects, issued two years ago by a Midwest experiment station, which says:

"The number of insect pests will be reduced, both directly and indirectly, by good cultural practices. Insects that live in the soil, such as white grubs and wireworms, are destroyed by plowing; cutworm damage is often reduced by keeping down weeds and grass on which the moths lay their eggs; and some of the fleabeetles are partially controlled by frequent cultivation. Moreover, plants in a thrifty condition will tolerate a moderate infestation of insects without serious injury and will recover more rapidly than unthrifty plants."

As one scans the history of insect invasions and fumbling attitudes by the public toward research and appropriations to give further studies and demonstrations in economic entomology, the similarity of it to the indifference of isolationists regarding the European war menace is striking.

Few realize the uncanny and terrific adjustment and adaptability possessed by most injurious insects. They say that man has lived on this earth for 400,000 years but insects in various forms have inhabited the globe for forty million years, cunningly contriving to outwit enemies and overcome unfavorable weather and learning far more than we know about the chemical juices of plants and how to tap them with least danger to themselves.

We read about the havoc and desolation of insects in some other state or county just as we used to read about the fiends of war let loose on some distant unpronounceable village—without batting an eye or getting hot for defense. In my own locality we heard about the menacing strides of the European corn borer, but only when a group of us backyard gardeners found such worms snugly burrowed into the tassels of our favorite variety of sweet corn did we let out a yell and ask the state entomologist why in blazes science hadn't conquered the varmint yet.

So widespread and universal has been this ignorance and smugness concerning bugs and worms on fruit and vegetable that I note with alarm that only this summer congress has gotten around to an official recognition and continuing appropriation for the specific control efforts of the Bureau of Entomology.

If we think maybe we have won the world war, or see its conclusion looming across bloody fields of combat and revolution, we are far from winning,

(*Turn to page* 51)

Florida citrus groves are usually located on sandy soils such as this one in Polk County.

Florida Knows How To Fertilize Citrus

By J. Francis Cooper

Editor, Florida Agricultural Experiment Station, Gainesville, Florida

A FERTILIZATION program for Florida citrus which keeps the trees producing at maximum capacity year after year, holds expense to the minimum, and materially reduces cold damage to both trees and fruit has been evolved by the Citrus Experiment Station at Lake Alfred. It has proven its merits in both experimental tests and commercial practice.

While good wartime prices for fruit have enabled growers to make profits in spite of occasional high costs, growers are well aware of the fact that the period following the war may —and probably will—bring a different story in its train. They have not forgotten that only a few years ago they were struggling with what seemed to be an insurmountable problem of reducing costs to the point where they could still make a profit under prevailing low prices. With production in Florida now double what it was a decade ago, with yields throughout the United States almost certain to continue increasing for many years, with canning plants taking a larger and larger proportion of the crop at prices much lower than those prevailing for fresh fruit, and with uncertainty surrounding postwar demand and prices, the growers know that a proper fertilization program is their best hope for the future.

Over the past two decades citrus growers have been confronted with first one deficiency and then another, as

organic fertilizers were replaced with inorganics. Research workers have tackled each deficiency in its turn and fortunately have determined the element in short supply which was causing the trouble. Copper was found to be the remedy for dieback, zinc for frenching, and magnesium for bronzing. At first, however, each element was considered more as a medicine than as a nutrient, and recommendations covered the cure but not the prevention of the trouble. Later research showed that by the time a trouble became obvious, production had already dropped at least 25 per cent.

Dr. A. F. Camp, Vice-Director in Charge of the Citrus Station, and his staff have done a fine job of correlating the work with various deficiencies, their regular fertilizer investigations, pH control studies, and even their spray schedules into a nutrition program which keeps all factors in proper balance and is giving results year after year. It works with all varieties of fruits, especially on the sandy soils on which a vast majority of Florida citrus groves are located.

The war emergency brought about a reduction in number from several hundred to 33 different fertilizer formulas in use in Florida, only a small proportion of the 33 being citrus fertilizers. It is entirely possible that the new coordinated program, which was already pretty well proved experimentally before the war started, will help to keep the number low after the war, since there will be no need for a multiplicity of fertilizer formulas to suit the fancy of each grower or a different fertilizer formula for each variety or kind of fruit.

The need for elements in addition to nitrogen, phosphorus, and potash has been evident for several years. The Citrus Station began to coordinate its program in 1936 and now has a recommendation that is meeting adequately the current needs. It can be changed, however, very easily if other deficiencies develop. The Station workers are recommending nitrogen, phosphorus pentoxide, potassium oxide, water-soluble magnesium oxide, manganese oxide, and copper oxide in the ratio of 4-6-8-(2 or 3)-1-½. It is not necessary to use that exact formula, but whatever formula is employed should follow those approximate proportions.

Most frequent difficulty encountered

A fertilizer sprayer in operation in a Florida citrus grove.

Spraying is a definite part of the nutrition program for Florida citrus in addition to controlling insects and diseases.

by growers who have attempted to follow the program has been the changing of the N-P-K ratios without changing the others to correspond, using something like an 8-12-16-3-1-½ instead of an 8-12-16-(4 or 6)-2-1. A second point of difficulty has centered around the grower's tendency to double the formula but not reduce his application by one-half, giving him a much more expensive fertilizer application.

Most Florida citrus growers fertilize their trees three times a year—about February, June, and September. Where groves are on heavier soils, however, some of them are fertilized only twice a year. Dr. Camp says the recommended formula is satisfactory for either two or three annual applications, and that it is suitable for each of the applications. However, if a grower wishes to vary the formula slightly by seasons, he can do this provided he makes sure that the total fertilizer applied for the year is in the recommended ratio of 4-6-8-(2 or 3)-1-½.

The trend toward the use of inorganic nitrates is credited with being a large factor in bringing on the very bad grove conditions which existed in Florida early in the decade beginning with 1930. The organics carried small amounts of other needed elements which the inorganics did not contain. At the Citrus Station one tier of plots which received all of their phosphate and about 65 per cent of their nitrogen from bone meal continued productive, while another tier receiving its superphosphate and either nitrate of soda or sulphate of ammonia developed the ailments common to commercial groves of 10 years ago. All of the plots were receiving what was considered a complete fertilizer.

There is as yet no conclusive evidence that inorganic nitrogen will be satisfactory over a period of years, even though magnesium, manganese, and copper are added to the fertilizer. No one knows when the reserves of some other element may be exhausted from the soil. Consequently, Dr. Camp recommends the use of from 30 to 40 per cent organic nitrates in citrus fertilizers where the organics can be obtained.

If organics cannot be obtained for all three applications, he thinks it more important to include them in the June application, which will be followed by more drastic leaching.

A 6 per cent level of phosphate set for this formula is 2 per cent lower than that of the 3-8-8 formula most widely used in the past for fertilizing citrus. The Citrus Station workers believed that with pH control, which is another necessary feature of their program, the phosphate would be more completely available than it is on very acid soils. To date they have seen no reason to change the phosphate recommendation from 6 per cent, which is lower than that used a few years ago.

That a phosphate deficiency is possible is evidenced by studies of Dr. J. R. Neller and Dr. W. T. Forsee of the Everglades Experiment Station at Belle Glade, Florida. On muck soils at Davie, fertilizer applications too low in phosphate resulted in fruit that softened prematurely and shed before becoming entirely ripe. Phosphate de-

ficiency produced light crops of poor quality fruit, just as any other deficiency does.

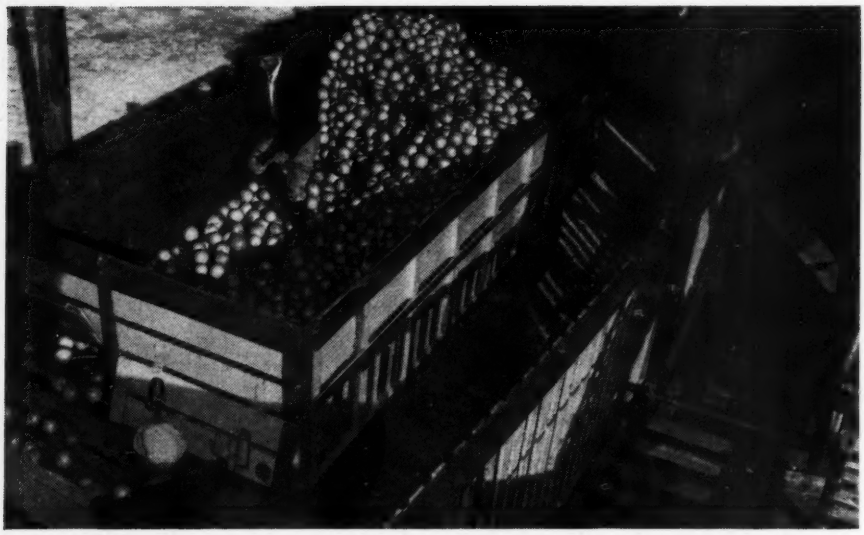
Dr. V. C. Jamison of the Citrus Station has found that superphosphate has little or no effect upon the fixation or solubility of zinc and copper in the soil. In instances where the application of reasonable amounts of superphosphate has been followed by zinc or copper deficiency, it has been found that before the phosphate had been applied fruit production was sufficiently low that the zinc and copper deficiencies were not evident. However, when the lack of phosphate has been limiting fruit production and this deficiency is removed, then either copper or zinc often becomes the limiting factor, thus giving rise to the erroneous belief that phosphate has tied up the other elements in the soil.

The 8 per cent ratio for potash was set partly because it was the percentage in standard usage, and partly because Dr. Michael Peech, formerly on the Citrus Station staff, had found that potash had not accumulated in the soils of a Station plot which had received 10 per cent potash applications for many years. Other investigators have shown a very rapid loss of potash in sandy soils, indicating that the citrus trees are largely dependent on annual applications of this element and that it would be a mistake to reduce applications too much.

Magnesium plays a particularly important role in keeping the trees bearing full crops year after year and avoiding alternation of cropping—a fair crop one year and a poor one the next. Pronounced deficiency of magnesium is evidenced in bronzing of the tree foliage, but marginal deficiencies may reduce yields without evidencing bronzing.

Dolomite is widely used in citrus groves to control pH and to furnish part of the magnesium requirements of the trees. Dr. Camp says that where the trees are in good condition and dolomite has been applied to the soil, a fertilizer containing 2 per cent of magnesium in a strictly water-soluble form, such as is contained in magnesium sulphate, is sufficient when the nitrogen level is at 4 per cent. It has been found, however, where lime or other basic materials low in magnesium are used to control pH, the magnesium ratio should be equal to the nitrogen

Virginia boys stationed at a farm labor camp at Winter Garden harvest citrus fruits, 1944. Proper citrus nutrition in this grove has increased yields.



With more fruit each year going to canning plants, economical fertilization becomes more imperative.

ratio, or 4 per cent. When magnesium-bearing materials not strictly soluble in water are used, where groves are either bronzed or in doubtful condition, and where the trees being fertilized are seedy grapefruit, it is safer to use 3 per cent magnesium, even in conjunction with dolomite.

The magnesium supply has been found to be the controlling factor in peel color.

The 1 per cent manganese included in the original master formula has been found to be sufficiently high. In fact, it has been difficult to show increased yields of fruit through the applications of manganese in the fertilizer applied to soils with a pH reading below 6.0, but fruit quality has been improved through its use. When the pH reading has been 6.0 or above, manganese has given increased yields.

Copper is recommended at ½ per cent when a copper spray is used, at 1 per cent when no copper spray is applied. However, results obtained without the spray have not been as satisfactoy as where the spray was applied, possibly due to the action of copper in the spray as both a fungicide and a nutrient. Copper in proprietary compounds is not as readily absorbed by the leaves as is that contained in bordeaux mixture.

Zinc is not recommended in fertilizers for Norfolk, Blanton, and Eustis sands since it appears to combine with organic compounds in the soil and become unavailable. Where frenching occurs, zinc sprays applied to the foliage have corrected the condition.

Control of pH has been shown to be a requisite part of this program, since a pH reading above 6.0 induces frenching or zinc deficiency, as well as manganese deficiency, while a pH reading below 5.5 is quite apt to induce bronzing or magnesium deficiency. Since maintenance of a constant pH is impossible, the Citrus Station staff recommends the application of dolomite or other basic material once a year sufficient to raise the pH to 5.5 or 6.0, and by the end of the year the pH reading probably will be down to around 5.3, giving a very good, safe range.

Framers of the program have made no attempt to specify the amounts of fertilizer which should be applied, since these will vary with age and condition of trees and other factors. However,

(*Turn to page* 49)

Potash For War Food

By Dr. J. W. Turrentine

Washington, D. C.

SUMMARY OF SUPPLIES

1943-44 agricultural potash supply for the United States, Puerto Rico, and Hawaii was 605,000 tons K_2O, which equals 109 per cent of the base (average deliveries of 1941-42 and 1942-43).

1944-45 supplies will be 725,000 tons K_2O, 130 per cent of the base.

WITH the final clarification of the potash supply situation for the fertilizer or crop year 1943-44 embodied in War Production Board releases of recent months, showing the allocation of agricultural potash for war-food use within the continental United States, Puerto Rico, and Hawaii, interest now shifts to the question of how much potash is going to be available for next year, 1944-45. It can be confidently expected that in dealing with this question realism based on experience will control deliberations and resulting plans during 1944. Pertinent thereto is the following statement from the War Production Board:

"Everyone concerned with the production of food and fiber crops in 1944-45 to meet record requirements is interested in learning as early as possible the outlook for fertilizer supplies. Among the interested groups are the War Food Administration, the agronomists and other agricultural workers in the states, the members of the fertilizer industry, and the producers of farm commodities. As a guide to these groups the War Production Board has attempted to estimate the supply of each major fertilizer ingredient which will be available next year for agriculture in the United States, including Hawaii and Puerto Rico.

"It should be emphasized, however, that any estimates made this far in advance, although based upon the most reliable information available, are subject to considerable error. Not only is it impossible to determine accurately what the domestic production of each material will be, but the quantities which will be imported are subject to considerable uncertainty and military requirements can only be estimated.

Potash Stabilized

"Potash perhaps is subject to less uncertainty than are most of the other fertilizer materials, the domestic production having become stabilized at a high level with the major producers operating 24 hours a day throughout the year. In 1943-44 the entire supply has come from domestic production and there is no assurance of any imports in 1944-45, although the possibility of obtaining shipments from Spain and Russia is being explored. In the current year out of a total production of 771,000 tons of K_2O approximately 100,000 tons were allocated to the chemical industry, a large part of the product going to meet direct or indirect military requirements. In the present estimate of supplies available for domestic fertilizer it is assumed that chemical requirements for potash will remain unchanged in 1944-45.

"According to present indications United States agriculture (including Hawaii and Puerto Rico) will have available in 1944-45 approximately 700,000 tons of K_2O from primary potash salts, an increase of 96,000 tons of K_2O, or 16 per cent, over the 604,000 tons allocated in 1943-44. It appears that there will be an increase of approximately 104,500 tons of K_2O in the form of high-grade muriate, while the supplies of 50 per cent muriate and manure salts will be reduced approximately 2,500 tons and 10,000 tons, respectively, of K_2O. Sulphate of potash

is expected to increase by approximately 4,000 tons of K_2O and the supply of sulphate of potash-magnesia will remain practically unchanged. Although it will vary for different salts, there will be approximately the same quantity K_2O allocated in Period Four (June 1, 1944, through March 31, 1945) as was allocated in Periods Two and Three combined.

"This anticipated increase in the supply of potash for agriculture is based on increased production capacity, elimination of lend-lease requirements, and more efficient utilization of existing production facilities. Plant expansion by one of the producers, already authorized by the War Production Board, is expected to provide 36,000 tons of K_2O in the last three quarters of the fertilizer year; approximately 20,000 tons exported under lend-lease in the current year are expected to be available for domestic use in 1944-45; and increased efficiency of production is expected to provide an increase of approximately 40,000 tons in production.

Increased Efficiency

"The increased efficiency of production had become evident by the beginning of 1944 and was one of the two factors which made it possible to increase Period Three (April and May 1944) allocations above the quantity which it previously had been estimated would be available for allocation. The other factor was the fact that the United Kingdom did not require delivery of the entire 36,000 tons of K_2O originally earmarked for lend-lease. Only 20,000 tons were taken, the remaining 16,000 tons becoming available for domestic use.

"In estimating the portion of the total domestic production of potash which will be available for agriculture, it is assumed that the requirements for industrial chemical uses will continue at the all-time high level reached in 1943-44, when the quantity allocated for these uses was approximately 100,000 tons of K_2O. If these requirements, a large part of which are for military purposes, should decline, the supply for agriculture will increase proportionately. It is also assumed that potash exports to countries other than the United Kingdom will be no larger than the quantities already approved."

It is recalled that early in 1943 potash was placed under allocation by the War Production Board, like most war emergency enterprises, a new experience for Government. As to potash supplies to be allocated, pretty definite information on domestic production was at hand—barring the unpredictable, but little was known of consumer demands, particularly those demands, like lend-lease exports and certain chemical and metallurgical uses intimately tied-in with the military backed by the ultimate of authority. Lend-lease commitments for export to the United Kingdom presented a major problem in estimating and apportioning requirements among those seeking supplies from American production, reaching at one time the total equivalent of 72,000 tons of 60 per cent muriate, partly as caustic potash, but principally as the agricultural grade of that highly refined salt in greatest demand. It was imperative that other sources of potash for British agriculture be drawn upon, an objective accomplished with the British return to Spain as a supplemental source of supply. In the offing, likewise, were actual and prospective demands for use in the agricultural rehabilitation of the areas rid of Axis domination by the armies of the Allied Nations. Again our domestic industry was (and still is) being viewed as the most convenient source of potash for these purposes, with quantities impossible to forecast. Fortunately, realism is prevailing and here again attention has been diverted to the Spanish exportable surplus as the more logical source, without that detriment to our own war food program so seriously threatened at one time.

From the beginning Canadian requirements have been cheerfully assumed as our obligation, on terms of exact equality with our own. But here

again the forecasting of these requirements proved to be no simple matter with a 100 per cent increase since 1938, according to the official figures of the Dominion Government—an increase from 21,000 tons in that year to 40,000 tons K_2O in 1943-44.

Potash in War

In the field of chemical usage, it was promptly recognized that among the potash derivatives there were many that had important, if not essential, functions in the production of munitions and other commodities with an intimate tie-in with the prosecution of the war. There could be no question, with respect to many of them, as to their essentiality. Against the background of only 15,000 tons K_2O delivered to the chemical industries in 1938, there appeared to be no basis for apprehension that the war-time needs could not be supplied without the serious impairment of crop production; but even if apprehension had been entertained, there still existed the priorities which had to be recognized as supporting the demands. These circumstances surrounding allocations of the highly refined chemical grades of potash salts account for the fact that chemical demands reached the total of 100,000 tons K_2O equivalent, which raises the questions of possible luxury consumption in some of the many uses to which potash is now being applied in the chemical and metallurgical industries; and whether the whole situation could not now be reviewed with profit in the search for certain tonnages, insignificantly small as separate items but important in the aggregate, that could be diverted back to agricultural use with greater returns to the over-all war program. Such an increase as has occurred here could not be foretold, at least with sufficient accuracy to add value to an allocation program.

Furthermore, early in 1943 the war-food program had not won its place in the public mind as second to none in importance among war efforts. The result was, in effect, that war food was allocated what was left after prior claimants, with what appeared to be superior authority, had been satisfied. In allocating this balance to agriculture, conservativeness was in order and the major problem was equality of treatment among some 700 fertilizer mixers. The so-called Period Two allocations were made under these considerations and on this basis; at the same time it was made clear that a supplemental allocation (Period Three) would be made, an additional 10 per cent being the conservative estimate. Unfortunately, that statement was largely ignored and planning was restricted to the tonnage previously allocated. Thus resulted misinformation and confusion from a clear effort to be conservative and accurate. Now we know, belatedly to be sure but nonetheless definitely, that the potash allocated to the fertilizer industry for distribution to the farmer during 1943-44 was 605,000 tons K_2O, which is 109 per cent of the base instead of the 80 per cent widely publicized during the 1943 period of discussion and planning.

During the calendar year 1943, the potash industry made deliveries of 723,000 tons K_2O, of which 591,000 tons K_2O were delivered for agricultural use within the continental United States. During the allocation periods of 1943-44, the War Production Board allocated 766,000 tons K_2O. Of this unprecedented total, 100,000 tons K_2O (in the form of the highest grades of salts) were allocated to the chemical industries, a more than six-fold increased consumption since 1938; 40,000 tons K_2O to Canada; 26,000 tons K_2O to exports; with the remaining 605,000 tons K_2O to the fertilizer industries of the United States, Puerto Rico, and Hawaii.

Adding to uncertainty to an even greater degree than the conservative treatment of the potash supply question was the difficulty of estimating the prospective mixed-goods tonnage output involving the appraisal of the combined effects of all the factors entering into

the preparation of mixed fertilizer under war-time conditions. These were and still are many. With scarcity of labor receiving most frequent mention, other deterrents to increased production are scarcity of materials of construction and repair, of bags, and of gasoline and rubber for truck distribution. Superimposed and aggravating the more commonly encountered obstacles is the seasonal nature of the industry with many activities habitually congested within the few months of the spring planting season. These obstructive factors are now fully recognized and sincere efforts are being made by government to reduce their adverse effects on output. The fertilizer industry, accepting the challenge to its proficiency, is bending every effort to produce the maximum tonnage possible under these many handicaps. The farmer, in response to widely publicized appeal by government and industry, has been lending his aid by buying early instead of at the planting season.

The Potash Ratio

With the end of the season now past the answer shortly will be forthcoming as to how effective these efforts have been in overcoming obstacles tending to block increased output. As to mixed-goods output, the official estimate is 7¾ million tons during 1943-44.

The obstacles mentioned above give added justification, if any were needed, for the early directive issued by the War Food Administration prescribing the 18 per cent plant-food minimum for mixed goods designed to reduce the content of inert fillers using up their proportionate share of labor, bags, and transportation facilities.

With the record of 1943-44 mixed-goods output in hand, it will be possible to deal more realistically with the question of the adequacy of potash supplies for the production of recommended grades. This was not easily possible during the past year in dealing with fertilizer goals based largely on measures designed to increase output whose efficacy had not been tested. As the result, in efforts to adjust an assured potash supply to that hoped-for output of mixed goods, an average potash ratio was projected far below that of the preceding year and so far out of line with recommended ratios as to threaten the abandonment of the scientific basis of crop nutrition, evolved as the culmination of decades of research, demonstration, and farm experience.

This threat was resisted by state officials with a sense of responsibility to the farmers of their respective states and the Nation's overall war-food demands, adhering to their scientific data in advising as to the most efficient combinations of the three major plant-food elements to be applied to crops in terms of their respective requirements for maximum yields as influenced by the soil conditions on which grown, facts falling within the scope of their expert knowledge. Their position reflected the conviction that any inadequacy of supply demanded more, not less, efficiency in use and that to meet the Nation's food goals called for by the war emergency, the ultimate of agricultural science should be applied, not abandoned merely to facilitate distribution.

According to the U. S. Department of Agriculture statistics, the average percentage potash content of mixed goods for the respective years 1938 to 1942-43 were as follows:

1938	5.94% K_2O
1939	6.06
1940	6.35
1941	6.60
1942	6.85
1943	7.50

These figures show an orderly rate of increase as state recommendations find wider acceptance by farmers. However, it should be pointed out in this connection that over-emphasis on averages can also prove misleading, for after all an average is only an elementary statistical expression without any agronomic or economic significance whatever, it being common knowledge

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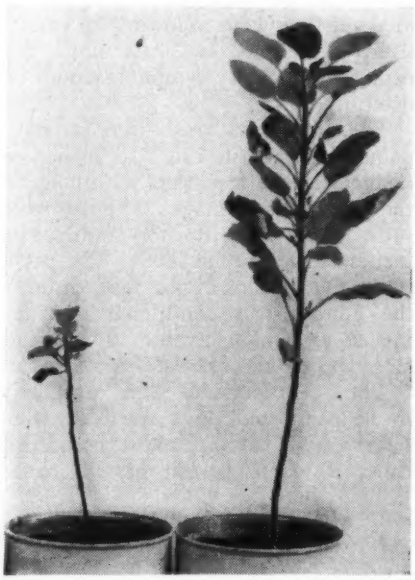
The Need For Borax On Fourteen Crops

By D. E. Dunklee and A. R. Midgley

Agricultural Experiment Station, Burlington, Vermont



Apple tree seedlings—without borax (left) were soon dead; with borax (right) were healthy.

FARMERS and vegetable growers have brought to our attention a number of crop troubles apparently nutritional in character. Since many of these troubles were suspected to be due to some phase of boron deficiency, we purposely boron-starved 14 important crops grown in the Northeast. These were grown on a very boron-deficient Vermont soil in order to more clearly recognize boron-deficiency symptoms under field conditions. The eventual objective is to find out what crops need borax and where it is needed as a farm fertilizer.

Plants starved for boron exhibit many diverse symptoms. The number of possible symptoms or phases of boron deficiency for each crop is almost unbelievable considering the small amounts of this element needed by plants. Burrell in relation to the apple describes at least five different symptoms (1) but apparently there are others.

We have obtained and corrected seven different symptoms of boron deficiency of alfalfa on a Vermont soil, namely, terminal dieback, rosetting, multiple branching, seed stripping, defective inflorescence, seedling death, and abnormal foliage coloration (4). The latter by some writers is called "yellows." Two other relatively unimportant symptoms, withered seed and root cankers, were also obtained and corrected. For alfalfa, no symptom corresponding to the "cracked stem" disease of celery has been observed, but such a symptom might exist.

We thus postulate that there can be at least all of these 10 different boron-deficiency symptoms for every kind of plant provided the proper degree of boron deficiency is attained. The extent or degree of each symptom depends on the time boron deficiency overtakes the plant and at what stage crop growth is arrested. Knowing only one symptom per plant does not seem to be the final answer. Until someone has reached into the grab-bag of nature and pulled out all symptoms, experimentally, as they occur in farm practice, we can still expect surprises. The symptoms probably express themselves more or less independently of each other or several of them at the

same time, as we have found for alfalfa.

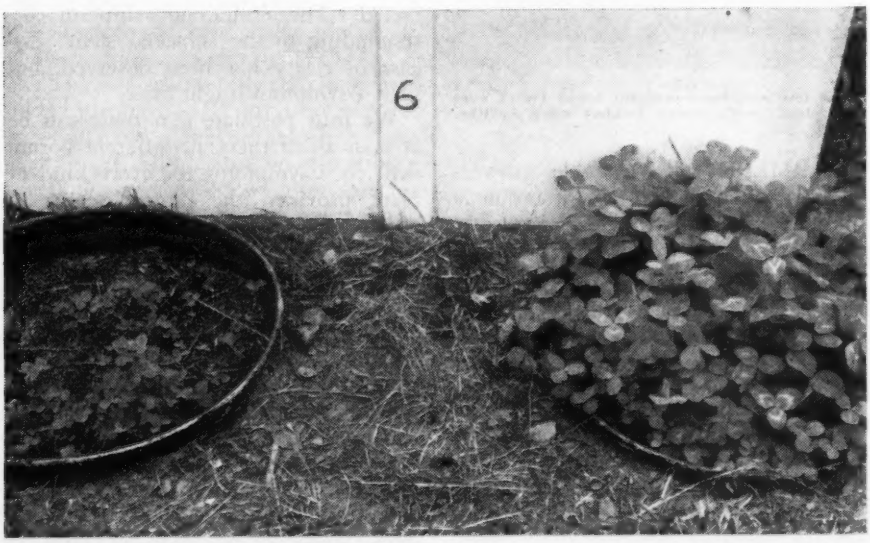
Some symptoms for each crop have economic importance, others do not, probably because they are microscopic and not easily observed. The fact remains, however, that there are still many symptoms for each crop yet to be reported, and that investigators may have missed certain prevalent symptoms which often betray the field need for boron as a fertilizer.

A five-year search has been in progress at this Station to see what diverse crop symptoms of boron deficiency could be uncovered. The writers believe that boron-fixing soils found in the podzol region offer a fertile field for further crop research since they provide suitable media for obtaining different levels of boron deficiency under field conditions. The following experiments are offered as progress in this direction.

These experiments were conducted in field pots because of difficulties previously encountered in large field trials. For two seasons before they were started, attempts had been made to produce and correct clear-cut cases of boron deficiencies in the field with 14 important crops. Although the experiments were conducted on a field where marked boron responses had been obtained with alfalfa, we had no luck in obtaining them with other crops, even though suspecting nutritional troubles were present. Difficulties encountered might have been due to either poor availability of borax, inability to control the level of the boron supply, unfavorable season, or lack of other necessary nutrients such as magnesium. At any rate, it seemed that more progress might be made on pioneer experiments if they were conducted in barrel-sized field pots, at least until the expected deficiency symptoms could be determined.

The field pots used were asphalt-painted metal ash cans, 18 inches in diameter and 2 feet deep, with holes in the bottom for drainage. The pots were sunk in the field, the top within two inches of the ground level. The possibility that plants might feed through the bottom was considered but dismissed as remote because of the character and depth of the soil employed.

These experiments were purposely to be conducted on a soil known to have a high capacity to fix boron, because it would permit growth to be



Red clover—no borax (left); with borax (right). Leaves of boron-deficient plants were lemon yellow colored, some also being streaked along the veins. With borax normal growth resulted.

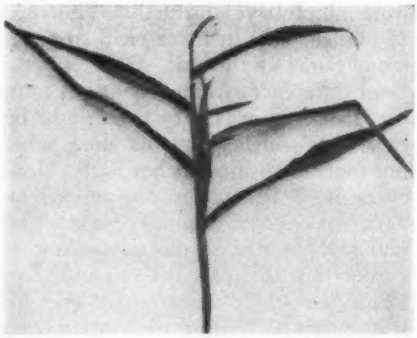
arrested at many different stages, and permit the use of ordinary commercial fertilizers, even though they may carry some boron impurities. Sand cultures were purposely avoided because they would be more artificial and involve much more trouble to attain severe deficiencies.

The soil selected was a very boron-deficient podzol topsoil from Breadloaf, Vermont. When limed to neutrality it fixes considerable amounts of boron out of reach of the crop. This soil contains more than 90 per cent organic matter, and it has been found that this organic part fixes boron, apparently functioning as an organic zeolite.

The soil in all pots was limed to approximate neutrality with ordinary ground limestone, fertilized with an ordinary 8-16-16 commercial fertilizer at 1,000 pounds per acre, and epsom salt at 200 pounds to supply magnesium. The fertilizer was calculated for the full depth of soil and mixed with it. Except for boron, all pots were fertilized exactly alike.

Borax was added to every other pot at 100 pounds per acre. This rate of borax seems to be necessary to grow plants on this high-fixing soil. The other pots were left entirely without borax or, because of no growth at all, borax was later added to several at the very low rate of 2 pounds per acre in water solution. The purpose was to obtain field pots with and without borax, but otherwise generously and equally fertilized. No irrigation was provided, rainfall being the only source of water for the crops, just as in field practice in this region.

Fourteen crops were planted—red and ladino clovers, timothy, oats, turnips, beets, carrots, sweet corn, lettuce, and string beans from seed, cabbage, broccoli and tomatoes from transplants, and potatoes from tubers. To fully eliminate genetic differences between potato seed pieces used, each seed tuber was cut through the stem end into equivalent sections. Half of each tuber went to the pot fertilized with borax, half to the pot without borax. This is really a tuber unit idea, a potato cut into equal units and a unit for each fertilizer treatment.* Potato seed pieces were thus approximately the same size and shape as used in farm practice. Soil was washed from roots of transplants to eliminate a carry-over of boron from the old to the new seedbed.



A corn plant without borax produced a rudimentary ear and folded leaves while the stalk lacked tassel and silk. Leaves were streaked and had a water-soaked appearance.

Since even in these experiments it was impossible to predict and control exactly the degree of boron deficiency and the age of the plant when growth was arrested, the symptoms reported represent only a few of the possibilities. They are striking but not necessarily the only ones sought. With many crops very outstanding boron deficiencies were obtained, as well as corrected, on this Vermont soil, although the symptoms were more severe than wanted.

Potatoes (Var. Green Mountain)—An extreme response to boron was obtained in spite of any boron which might have been carried in the seed pieces. Leaves of the boron-deficient potato plants appeared markedly rolled upward and were abnormally brittle and tough. They were suggestive of the potato leaf roll virus disease except for their pale dirty green coloration.

Potatoes with borax yielded 1,296 gms. of good tubers per pot; without borax, 52 gms. of small tubers which

* Tuber unit fertilization is a very useful procedure in other potato nutritional work to equalize genetic differences in seed.

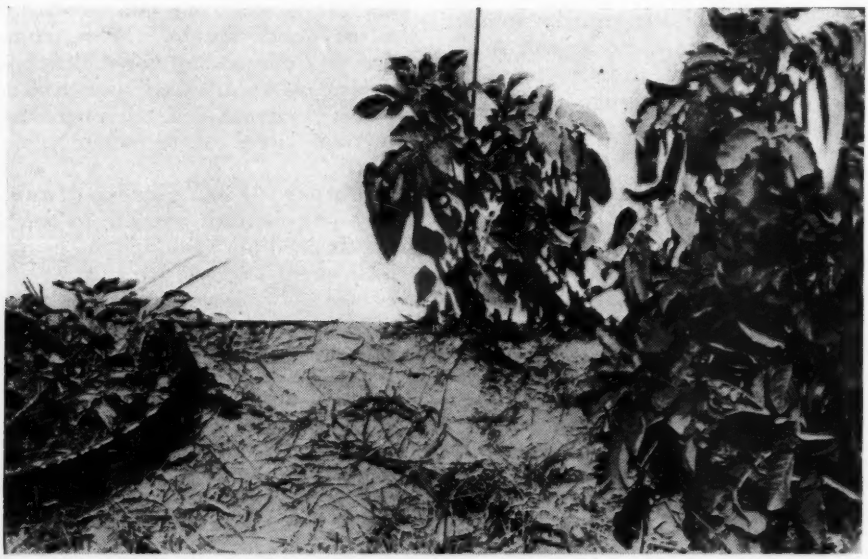
were absolutely worthless. This is a 25-fold increase in tuber yield from the use of borax on this soil. These extreme yield differences were obtained because the deficiency was very severe and because the deficient plants died when not more than nine inches high. However, the deficiency is not as extreme as it is possible to attain, because a two-year starvation with the elimination of boron from the seed piece should cause still more severe symptoms. We predict extreme variation in symptoms between the severe deficiency obtained and those which overtake the potato plant after it is older.

Potato plants starved for boron suffered a severe attack of early blight while right beside them those receiving boron escaped it. This happened when the deficient plants were less than eight inches high. The fungus was identified in the field by Dr. Lutman, the Station Pathologist. Leaves of deficient plants rolled upward more than normally, were plastered with brown patches of this fungus, and were a dirty pale green in color.

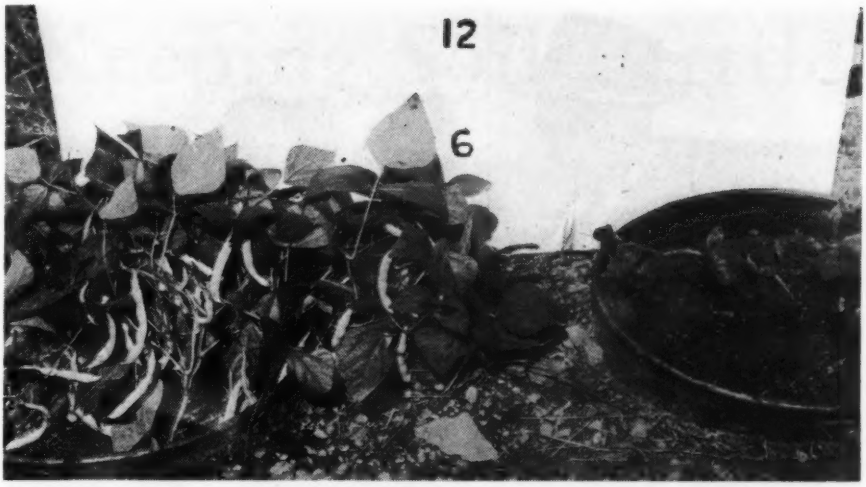
In contrast, plants fertilized with borax were healthy, free of early blight fungus, lived until frost time, and produced a crop of clean, healthy tubers. Severe boron starvation thus fostered a clear-cut attack of early blight while borax in the fertilizer completely corrected it. This probably will happen again if the experiment is repeated, but of course the only way to be absolutely sure is to try it another year. Heinrich has also found that boron reduced the amount of potato blight (5). In a sense, our observation is confirmed by him although it is not clear whether he refers to late or early blight.

Bordeaux spray is commonly considered the remedy for early blight. Here, however, the attack occurred on the boron-deficient plants even though they had been well and frequently sprayed with a home-made 6-6-50 bordeaux. From this one experiment it would seem that boron in the fertilizer was very helpful in preventing the early blight of the potato. It should be remembered that both boron and bordeaux are antiseptic in their action and might both function in a similar way, although it is likely that lack of boron increased plant susceptibility to blight.

Boron-deficient tubers at digging



Potatoes—no borax (left); with borax (right). Note the upward rolling of leaves and the dwarfing of plants due to lack of boron. With borax, plants were normal.



String beans—with borax (left) a prolific crop of beans was produced; without borax no beans formed.

time were more withered, rusty brown colored, and punky on the outside than potatoes that had been in the cellar for a year. The skin when cut was thick, corky, russeted, and finally cracked. Inside, the flesh was a solid rusty brown color except for a very small white area in the central part of the tuber. The vascular ring was obscured by browning. The tubers were very watery. None was larger than a golf ball. The watery internal condition indicated that the starch had not been accumulated in the tuber in the normal fashion. The brown internal color was the same shade as that causing net necrosis and stem-end browning of the potato. Further experiments are needed to determine what lesser degrees of boron deficiency look like midway between the solid browning we obtained, which severely dwarfed the tuber, and the normal white internal condition. Until proved otherwise, there is a possibility that the right degree of boron deficiency might induce symptoms similar to net necrosis or stem-end browning in the tuber. One might think that what is known about net necrosis would eliminate a nutritional explanation. Nevertheless, present information might be merely fragments of the truth.

Turnips—Rutabagas—A marked response of turnips to borax was obtained. Without it, seedlings became straw colored and died when less than two inches high. The boron-deficiency symptom obtained in this case was the death of the seedlings. With borax, normal plants were obtained and continued to grow vigorously through the season. Yields, being meaningless, were not taken. In this case the deficiency was so severe that the turnips did not grow large enough to produce the characteristic brown heart usually reported as a result of boron deficiency.

String Beans (Var. Black Wax)—String beans responded markedly to borax. Without it, they quickly grew two leaves beyond the cotyledons and thereupon were attacked by fungous diseases. Although they made some further futile attempts to grow, no blossoms formed and no fruit was set. Growth was finally arrested midway between the seedling stage and flowering. Leaves were first dirty green, tending to become yellow and brown. With borax, normal growth was obtained, fungi did not attack, and the plants flowered profusely and produced a prolific crop of beans. Failures to form flowers, pods, and seed were the deficiency symptoms most obvious in

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Roscoe Fraser of Purdue and Shirley Fredericks of Lafayette comparing color on thumbnails with a ripe tomato to help determine when the tomatoes have proper color for picking.

Eliminates Guesswork From Tomato Picking

ROSCOE FRASER, Purdue University Tomato Specialist, has at last found a practical use for the brilliant red nail polish which to date has been employed solely for the glamourizing of the finger and toe nails of women.

It all came about while Fraser was dictating letters one day last spring. His secretary was having her bad moments over his dictation, and almost literally pulling her hair, which made Fraser nervous. Her brilliantly polished nails also added to his distraction, until he suddenly remembered his annual problem of teaching prospective tomato pickers to select fruit of the proper shade of red.

U. S. No. 1 tomatoes are 90% good red color, while the No. 2 grade are only 66⅔% good red. To date it has been necessary for pickers to keep in mind the desired shade of red while searching among the vines for the select color.

Fraser hit upon the idea of painting the thumb nails of the pickers with the exact desired shade of tomato-red nail polish, thus keeping constantly before their eyes the proper degree of color.

The thumbs are always in view of the picker and can be easily compared with the tomato he is about to pick. If the fruit is not the correct shade, he can pass on to the next hill. When the nails become covered with dirt, the soil is easily removed in one swipe from the hard-surfaced polish, thus insuring a uniform, unchanging color chart constantly before the eyes of the picker.

Keeping Soil Fertile In The Pecan Orchard

By J. H. Hunter

Associate Soil Technologist, U. S. Department of Agriculture, Albany, Georgia

THE maintenance of soil fertility in pecan orchards for the successful production of nut crops involves timely applications of the proper kinds and amounts of commercial fertilizers and the growing of suitable cover crops. It has a relation to the profitableness of the control of insects and diseases affecting the trees, as well as to that of other orchard operations. In fact, profitable production of pecans over a period of years cannot be expected unless a complete orchard-management program is followed.

Unless diseases and insects are controlled, the full value of fertilizers and green-manure crops will not be obtained; and if the orchard needs thinning or is not properly cultivated, dry weather may limit or entirely offset the beneficial effects of fertilizers and green-manure crops. Furthermore, if tree vigor is low and only light crops of nuts are set, the returns from spraying to control diseases and insects will be very small. Proper attention to the fertility of the soil usually results in vigorous trees which should set heavy crops, thereby substantially reducing the cost of nuts per pound.

Winter legumes are probably the most important single item involved

Austrian winter peas and Abruzzi rye green-manure crop growing on Norfolk sandy loam soil adequately fertilized with phosphorus and potash. Photograph was taken April 17 just prior to disking crop into the soil. Note that the tree is just beginning to bud out.

Hairy vetch and Abruzzi rye green-manure crop growing on Norfolk sandy loam soil adequately fertilized with phosphorus and potash. Photograph was taken April 3, about 2 weeks before disking crop into the soil. Note that the tree is still dormant.

in maintaining the fertility of the soil in the orchard. They are recommended in preference to summer legumes because summer crops, although valuable in improving fertility of the soil, compete with the trees for both nutrients and moisture.

It has been found, however, that the winter legumes will not make satisfactory growth on a majority of the Coastal Plain soils of the Southeast without commercial fertilizers. As a general practice, 300 to 400 pounds of superphosphate per acre, or the equivalent from other phosphate materials, and 100 pounds of muriate of potash should be broadcast annually prior to or at the time of seeding the green-manure crops. Where more convenient, a 0-14-10 fertilizer may be applied at the rate of 400 to 500 pounds per acre. If these fertilizers should fail to produce satisfactory growth of the legumes, the soil should be tested for lime requirement, and lime used only if a deficiency is indicated by the tests.

As a general thing, lime is not recommended for pecan orchard soils because overliming may upset the availability of the zinc in the soil and cause the trees to rosette. Even without the use of lime, a good soil-fertility program for pecans frequently creates a greater demand by the pecan tree for zinc than many of the soils of the Southeast will supply, and in many cases the grower should expect to use zinc sulfate to supply this need.

Experimental results as well as the experience of growers have shown that hairy vetch is the most reliable winter green-manure crop for planting in the Southeastern pecan-producing section. Austrian winter peas are planted widely but their growth is frequently reduced by diseases if planted successively. Their one advantage over hairy vetch is that they make more growth during the winter than the vetch.

As is the case with other crops, it is best to rotate, and on the heavier soil types Abruzzi rye may be used to advantage about one year in three. Data by Lewis and Hunter [1] in studies

[1] Lewis, Rulon D., and James H. Hunter. The nitrogen, organic carbon, and pH of some Southeastern Coastal Plain soils as influenced by green-manure crops. Jour. Amer. Soc. Agron., Vol. 32, No. 8, 1940.

made outside the orchard show that the nitrogen level in the soil was maintained when rye was used in rotation with vetch and Austrian peas. For a period of four years in which rye was used once, the nitrogen in Greenville sandy loam soil was increased in percentage content over that originally contained in that soil by an average of 0.02 and in Norfolk sandy loam soil it was increased by an average of 0.01. Converting these figures to pounds of nitrogen per acre of surface soil (2,000,000 pounds) gives an increase in soil nitrogen of 400 and 200 pounds per acre for the respective soils, or the equivalent of 2,000 and 1,000 pounds per acre of a fertilizer containing 20 per cent nitrogen.

Hairy vetch alone, or a mixture of 5 pounds of Abruzzi rye to 25 pounds of vetch, should be sown at the rate of 25 to 30 pounds per acre; and Austrian winter peas alone, or a mixture of 5 pounds of Abruzzi rye to 25 pounds of peas, should be sown at a rate of 35 to 40 pounds per acre. Abruzzi rye, if used alone, should be seeded at the rate of 50 to 60 pounds per acre. Ten to 15 pounds of oats may be substituted for the 5 pounds of rye in the mixtures if the seeding rate is increased accordingly. Seeding should be completed by October 15 for best results. Inoculation of seed of all legumes is necessary when planted for the first time, and inoculation of the seed each year is probably good insurance. A good seedbed is essential if good stands are to be obtained, but this will not be difficult if the soil has been properly cultivated throughout the summer.

When rye is used alone as a green-manure crop, it should be disked into the soil during the pre-blooming stage. This is important because the rye plant decreases rapidly in percentage nitrogen content from this stage to maturity and may become too low in nitrogen content for decomposition to proceed rapidly when turned into the soil. If this does happen the nutrients

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Abruzzi rye green-manure crop growing on Greenville sandy loam soil following three years of winter legumes. Photograph was taken March 20 at the time of disking the crop into the soil. When rye is used alone, it should not be allowed to grow beyond the pre-blooming stage as the percentage nitrogen content of the rye plant decreases with age and may become too low for rapid decomposition.

Soil Fertility's Effect On Asparagus

By Benjamin Wolf

Soil Chemist, Seabrook Farms, Bridgeton, New Jersey

THE growing of asparagus has become an important industry for New Jersey farmers. About 22,000 acres were grown in 1943 and its value approximated $7,000,000. A good portion of this asparagus is canned. Because of the value involved, the satisfactory production of quality asparagus in the State is directly important to growers, processors, and consumers.

The G.L.F.—Seabrook Farms Raw Products Research Division—a research organization sponsored by the G.L.F., a leading farmers' cooperative in the area, and Seabrook Farms, largest vegetable farm in the world—has been studying the influence of soil fertility upon the gross dollar returns per acre of asparagus. The gross dollar returns per acre were used as an index of quantity plus quality production.

The results of the two years of study suggest the possibility of materially increasing the dollar returns by paying proper attention to the fertilizer practice. High gross dollar returns per acre, which mean high yields of good quality, are always important but are doubly so during wartime. The findings of this study are herein briefly presented so that they may be of benefit to people beyond this immediate area.

In making this study, thirty asparagus growers in 1942 and again in 1943 were selected from a list of those growers contracting their crop with Deerfield Packing Corporation, the packing division of Seabrook Farms. The growers were selected so as to give a wide variation in the average dollar returns per acre. In 1942, the gross returns per acre for the thirty growers selected ranged from $37 to $391. In 1943, twenty farmers of the original group and ten different farmers had average returns ranging from $95 to $504 per acre.

In selecting the fields for study, only beds from 5-12 years of age were considered: In this manner, low returns due to the extreme youth or old age of the bed were largely eliminated.

The soils on which the asparagus was grown were of Coastal Plain origin and belong primarily to the Sassafras series. Samples of the surface soil (0-6″) and of the subsoil (6-12″) were selected just prior to the end of the cutting season from all fields. A composite sample of five borings was used to represent an area of no more than five acres. The samples were analyzed by rapid methods which permit a fairly accurate determination of nutrients.[1]

The average results of soil tests were correlated with the average dollar returns per acre. The association of various levels of nutrients with dollar returns per acre for the two years is presented in Table I.

The association of the amounts of phosphorus and potassium in both surface and subsoil with the dollar returns per acre is most striking. Witness the 1942 returns of $225 per acre where the soluble phosphorus content of the surface soil was over 30 lbs. per acre as compared to only $125 returns for those soils having less than 15 lbs. of

[1] Wolf, B. "Rapid determination of soluble nutrients in soil and plant extracts." Ind. and Eng. Chem. Anal. Ed. Vol. 15, p. 248-251, 1943.

soluble phosphorus per acre. Also, the returns of $240 per acre when the soluble potassium was between 300-400 lbs. per acre, as compared to $170 per acre for those fields containing 100 to 200 lbs. of soluble potassium per acre. The presence of sufficient soluble phosphorus and potassium in the subsoil was even more important. The results for 1944 are essentially the same and reaffirm the findings of 1943.

The presence of sufficient calcium and magnesium was desirable, but the importance was overshadowed by the effects of phosphorus and potassium. However, there was a definite trend in favor of higher amounts of these elements. It would seem to be necessary to have not less than 500 lbs. of soluble calcium in the surface soil, and higher amounts would be an added asset.

The effects of pH and organic matter (Table II) also seem to be somewhat overshadowed by the importance of phosphorus and potassium. Again, there are definite trends in favor of higher pH values in both surface and subsoil and organic matter in the surface soil.

Attempts were made to explain the

TABLE I.—THE AVERAGE DOLLAR RETURNS PER ACRE OF ASPARAGUS AS ASSOCIATED WITH VARIOUS AMOUNTS OF DIFFERENT NUTRIENTS

Element and Location	Amount, lbs.* per acre	Dollar returns per acre	
		1942	1943
Surface phosphorus	Less than 15	125	180
	15–30	225	235
	30 or more	225	300
Subsoil phosphorus	Less than 5	115	180
	5–10	160	220
	10–15	250	265
	15 or more	280	270
Surface potassium	100–200	170	185
	200–300	225	215
	300–400	240	245
	400 or more	...	260
Subsoil potassium	Less than 50	110	140
	50–100	160	165
	100–150	220	200
	150–200	250	220
	200 or more	290	280
Surface calcium	Less than 500	...	140
	500–1,000	190	200
	1,000–1,500	225	240
	1,500 or more	...	260
Subsoil calcium	Less than 500	...	230
	500–1,000	190	240
	1,000 or more	230	250
Surface magnesium	Less than 100	205	200
	100–200	195	220
	200 or more	235	225
Subsoil magnesium	Less than 50	210	205
	50–100	205	215
	100–150	220	225
	150 or more	...	240

* Assuming 2,000,000 lbs. of soil per plowed acre. Soluble nutrients present at end of cutting season.

TABLE II.—THE ASSOCIATION OF VARIOUS LEVELS OF pH AND ORGANIC MATTER WITH DOLLAR RETURNS PER ACRE OF ASPARAGUS

Factor	Amount	Dollar return per acre	
		1942	1943
Surface pH	Less than 5.0	180	205
	5.0–5.5	230	225
	5.5–6.0	200	230
	6.0 or more	230	240
Subsoil pH	Less than 5.0	...	190
	5.0–5.5	230	220
	5.5–6.0	225	210
	6.0 or more	230	240
Surface organic matter	Less than 1%	200	180
	1.0–1.5	210	230
	1.5% or more	240	245
Subsoil organic matter	Less than 1%	190	230
	1.0–1.5	220	220
	1.5% or more	...	230

difference in amounts of phosphorus and potassium by the system of fertilization. It was difficult to obtain clear records for a number of years. However, by comparing the practices of the group having high dollar returns with those of the group having low dollar returns per acre, it was possible to evaluate fertilizer practices in keeping with these returns.

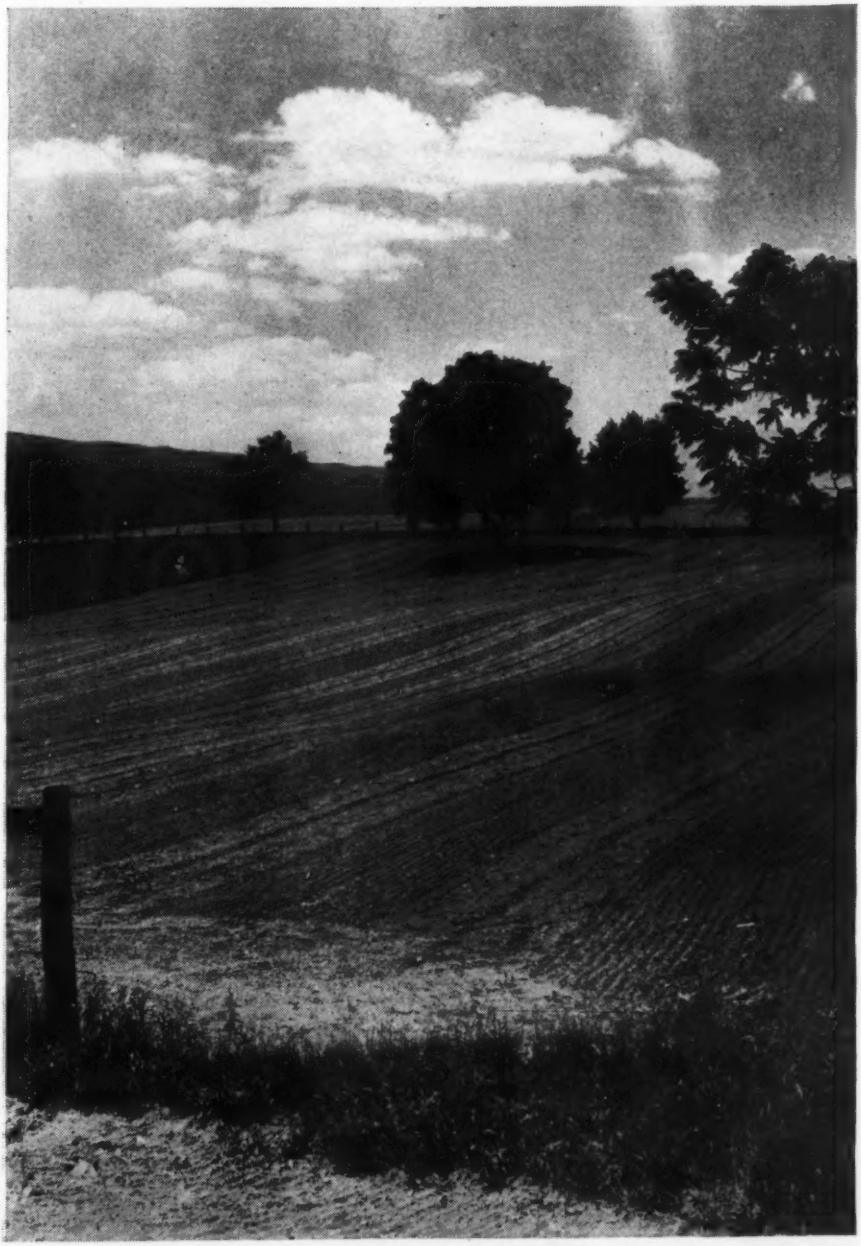
Those farmers who had planted their asparagus roots in fertile soil and had fertilized annually with approximately 2,000 lbs. of a 5-10-10 fertilizer, or something near its equivalent, had high amounts of phosphorus and potassium in both surface and subsoil and high returns per acre. Some of the growers in this group had used only 1,000 lbs. of fertilizer until actual cutting had started. The majority of those obtaining high returns had limed rather liberally and consistently to keep the pH value close to 6.0. Conversely, those obtaining low returns per acre had planted roots in rather infertile or poorly prepared soil and had skimped on the amounts of fertilizer or lime, or both.

From these studies, it would seem to be desirable to have at the end of the cutting season on an acre basis, and as represented by rapid tests, the following amounts of nutrients: At least 30 lbs. of soluble phosphorus in the surface and 15 lbs. in the subsoil, and about 400 lbs. soluble potassium in the surface and over 200 lbs. in the subsoil. It would also be desirable to have 1,500 lbs. soluble calcium in the surface and over 1,000 lbs. in the subsoil, over 200 lbs. magnesium in the surface and over 150 lbs. in the subsoil. A pH value of at least 6.0 in the surface and subsoil and an organic matter content of more than 1.5 per cent would be added assets.

Proper fertilization and liming evidently assure the presence of the necessary fertility conditions. Annual use of 2,000 lbs. of a 5-10-10 or its equivalent to plants set in fertile soil and consistent and adequate liming were satisfactory in this particular study.

The results point to the importance of sufficient nutrients in depth for asparagus. It would appear that for many soils in the Coastal Plain area normally having low concentrations of nutrients in the subsoil, a substantial improvement in the soil fertility might be made by incorporation of dolomitic limestone, phosphorus, and potash in the subsoil before planting.

PICTORIAL



A well-prepared and fertile seedbed is half the battle.

Above: Members of the U. S. Crop Corps turned out to pick tomatoes in the Shenandoah Valley.

Below: In the same Valley, apples were another crop utilizing the help of these vacationists.

Above: M. L. Wilson, Secretary Wickard, and Marvin Jones look over support of Food Program.

Below: A camp in the Shenandoah Valley where U. S. Crop Corps lived while helping farmers.

Courtesy Union Pacific Railroad Agricultural Development Department

The Vacations We Didn't Get!

The Editors Talk

Is Plowing Folly?

Who would have believed that so many people would become excited over so common an activity as plowing, regardless of what was said about it? Probably no one, including even Edward H. Faulkner, himself, when he wrote "Plowman's Folly." Plowing in one form or another is nearly as old as agriculture itself and in years past has evoked a certain amount of interest and inspiration in the minds of scientists and poets. They did not question whether or not we should plow, but concerned themselves with how to plow and the sentiments aroused by plowing. Faulkner believes, however, that we should not plow at all, ascribing many of our ills and troubles to that time-honored practice. This started no end of discussion by writers in farm magazines, daily newspapers, and technical journals and extended even to those who ride Pegasus.

We find one of the leading literary magazines of the country carrying a critique of Faulkner's teachings by one of the leading soil scientists of the country. Harper's Magazine for July 1944 has an article by Professor Emil Truog of the University of Wisconsin entitled, "Plowman's Folly Refuted." An equally interesting but more detailed discussion of the principles of plowing by Dr. W. A. Albrecht, well-known Chairman of the Soils Department of the University of Missouri, appeared in 1943 summer issues of Better Crops With Plant Food under the title of "Why Do Farmers Plow?" Many others have expressed their views on Faulkner's book specifically or on the general subject of plowing.

The Importance of Judgment

Both Professor Truog and Dr. Albrecht do not fully agree with Faulkner. Objection is made to sweeping statements based on speculation, casual observations, or sketchy trials. On the other hand, they do not entirely disagree with some of the theses of "Plowman's Folly." In common with most soil scientists, they agree that plowing can be overdone and can be harmful under certain circumstances. When properly practiced, however, it is a very useful and efficient means of effecting certain desired soil conditions preparatory to growing a crop. As Dr. Albrecht writes, "Fortunately, the plow is merely a tool in this whole matter under discussion. The concern about the practice of plowing is one that brings into question the judgment of him who is using the tool, and the purposes he has for it in relation to the soil as a national as well as an individual asset. One cannot condemn the rifle or the pistol as tools because these are now being used in war, when they can render so many more desirable services. Nor would we condemn the mechanics of the automobile when in its human destruction the fault is not one of the machine but rather one of 'the nut that holds the wheel.'"

It is pointed out that one of Faulkner's objections to the plow is the fact that it places the organic matter and plant nutrients too deeply in the soil. Professor

Truog shows that actually this is an argument for plowing. He also lists the other reasons for plowing:

"(1) Plowing, because of the special shape of the moldboard, produces a shearing action in three directions on the thick layer of soil that is lifted and turned. As a result, the turned soil layer is pulverized, and thus a more satisfactory seedbed is possible than with an implement that turns shallow layers.

"(2) Plowing also helps to improve and rejuvenate soils by bringing the deeper layers from time to time near the surface where the desirable processes of aeration, oxidation, and alternate freezing and thawing are more active.

"(3) And by plowing under organic matter it is possible to maintain an active soil layer deep enough to provide satisfactory conditions for crop plants."

Referring to Faulkner's contention that if there were no plowing, no fertilizer would be needed, Professor Truog writes, "The author of Plowman's Folly made an error when he connected nature's bountiful yields and towering trees with his no-fertilizer theory. In nature's cropping scheme, there is no removal of plant growth with accompanying soil elements, as there is in man's program of food production. Man harvests and carries away the corn and wheat, rich in fertility elements; but nature's crops are left to die, rot, and add to the fertility of the soil. This cycle is repeated year by year, and gradually insoluble soil minerals are changed over to more soluble or usable products.

"If nature's soil could, by itself, nurture a nation of 130,000,000, all soil and crop specialists would be without jobs, for all the farmers would have to do would be to sow and reap. However, the constant harvesting of crops gives us as food the nutrients which nature would normally return to the soil. Therefore, we cultivate the land and give back in the form of fertilizer the nutrients we have removed in crop form.

"Farmers now know that land which is in pasture continuously, and is never plowed, gradually deteriorates in fertility. Like all harvesting, the pasturing of cattle removes nutrients from the soil. It is not plowing, but the removal of vegetation, that causes depletion; if no vegetation is removed, the soil retains its fertility. This is the ABC of agriculture."

Plow Is Not Fertility Exploiter

On the same subject, Dr. Albrecht writes, "Plowing merely hastens many of the same processes that are occurring more slowly when 'the land is resting.' When land must be allowed to rest in order to boost its productivity back to economic levels again, this is merely proof that the fertility supply on the clay is exhausted so nearly to completion and the mineral reserve of fertility has fallen so low that the interactions between the clay and the minerals are too slow to move enough nutrients onto the clay surface to provide sufficiently for the roots during the growing season. Plowing isn't the cause of the depletion of the fertility supply. Depletion occurs because of the fertility removed within the crop hauled off. The plow is not the exploiter; rather, it is the farmer. The plow is merely the tool that facilitates his exploitation at a faster rate and over more acres than before the plow was given him. The plow has helped him to feed many of us too far removed from the land to appreciate its exploitation."

Dr. Albrecht and Professor Truog are performing a service of great value in explaining so clearly for the layman many of the controversial points raised by Faulkner. Probably agriculture is indebted to the author of "Plowman's Folly" for raising issues concerning plowing and thereby making all of us think about the subject. He has made us realize that there can be two sides to every question, even plowing. We should not go overboard one way or the other. Articles such as those of Dr. Albrecht and Professor Truog are needed to round out the picture and re-establish the equilibrium.

Farm Prices of Farm Products*

	Cotton Cents per lb.	Tobacco Cents per lb.	Potatoes Cents per bu.	Sweet Potatoes Cents per bu.	Corn Cents per bu.	Wheat Cents per bu.	Hay Dollars per ton	Cottonseed Dollars per ton	Truck Crops
1910–14 Average	12.4	10.4	69.6	87.6	64.8	88.0	11.94	21.59	....
1920	32.1	17.3	249.5	175.7	144.2	224.1	21.26	51.73	....
1921	12.3	19.5	103.8	118.7	58.7	119.0	12.96	22.18	....
1922	18.9	22.8	96.7	104.8	58.5	103.2	11.68	35.04	....
1923	26.7	19.0	84.1	104.4	80.1	98.9	12.29	43.69	....
1924	27.6	19.0	87.0	137.0	91.2	110.5	13.28	38.34	....
1925	22.1	16.8	113.9	171.6	99.9	151.0	12.54	35.07	....
1926	15.1	17.9	185.7	156.3	69.9	135.1	13.06	27.20	....
1927	15.9	20.7	132.3	114.0	78.8	120.5	12.00	28.56	....
1928	18.6	20.0	82.9	112.3	89.1	113.4	10.63	37.70	....
1929	17.7	18.6	93.7	118.4	87.6	102.7	11.56	34.98	....
1930	12.4	12.9	124.4	115.8	78.0	80.9	11.31	26.25	....
1931	7.6	8.2	72.7	92.9	49.8	48.8	9.76	17.04	....
1932	5.8	10.5	43.3	57.2	28.1	38.8	7.53	9.74	....
1933	8.1	12.9	66.0	59.4	36.5	58.1	6.81	12.32	....
1934	12.0	17.1	68.0	79.1	61.3	79.8	10.67	26.12	....
1935	11.6	16.1	49.4	73.9	77.4	86.4	10.57	35.56	....
1936	11.7	17.2	99.6	85.3	76.7	96.0	8.93	31.78	....
1937	11.1	19.9	88.3	91.8	94.8	107.1	10.36	30.24	....
1938	8.3	17.2	55.5	76.9	49.0	66.1	7.55	21.13	....
1939	8.7	13.6	68.1	75.4	47.6	63.6	6.95	22.17	....
1940	9.6	15.1	70.7	85.2	59.0	73.9	7.62	24.31	....
1941	13.3	19.1	64.6	94.4	64.3	84.0	8.10	35.04	....
1942	18.51	28.3	110.0	108.3	79.5	101.8	10.05	44.42	....
1943									
July	19.60	59.0	167.0	267.0	108.0	126.0	11.90	44.50	....
August	19.81	38.4	159.0	276.0	109.0	127.0	12.20	50.90	....
September	20.20	37.2	134.0	231.0	109.0	130.0	12.90	51.90	....
October	20.28	41.8	128.0	196.0	107.0	135.0	13.70	52.50	....
November	19.40	44.5	133.0	177.0	105.0	137.0	14.50	52.50	....
December	19.85	42.4	135.0	188.0	111.0	143.0	15.20	52.60	....
1944									
January	20.15	41.5	141.0	202.0	113.0	146.0	15.70	52.80	....
February	19.93	25.1	139.0	211.0	113.0	146.0	15.90	52.60	....
March	19.97	21.9	137.0	220.0	114.0	146.0	16.00	52.70	....
April	20.24	23.8	137.0	229.0	115.0	147.0	16.20	52.50	....
May	19.80	37.2	134.0	236.0	115.0	147.0	16.10	52.50	....
June	20.16	49.2	125.0	233.0	115.0	143.0	15.00	52.80	....
July	20.32	45.0	138.0	230.0	117.0	139.0	13.90	53.00	....
Index Numbers (1910-14 = 100)									
1920	259	166	358	201	223	255	178	240	....
1921	99	187	149	136	91	135	109	103	....
1922	152	219	139	120	90	117	98	162	....
1923	215	183	121	119	124	112	103	202	....
1924	223	183	125	156	141	126	111	177	150
1925	178	161	164	196	154	172	105	162	153
1926	122	172	267	178	108	154	109	126	143
1927	128	199	190	130	122	137	101	132	121
1928	150	192	119	128	138	129	89	175	159
1929	143	179	135	135	135	117	97	162	149
1930	100	124	179	132	120	92	95	122	140
1931	61	79	104	106	77	55	82	79	117
1932	47	101	62	65	43	44	63	45	102
1933	65	124	95	68	56	66	57	57	105
1934	97	164	98	90	95	91	89	121	104
1935	94	155	71	84	119	98	89	165	126
1936	94	165	143	97	118	109	75	147	113
1937	90	191	127	105	146	122	87	140	122
1938	67	165	80	88	76	75	63	98	101
1939	70	131	98	86	73	72	58	103	109
1940	78	145	102	97	91	84	64	126	121
1941	107	184	93	108	99	95	68	162	145
1942	149	272	158	124	123	116	84	206	199
1943									
July	158	567	240	305	167	143	100	206	315
August	160	369	228	315	168	144	102	236	308
September	163	358	193	264	168	148	108	240	311
October	164	402	184	224	165	153	115	243	264
November	156	428	191	202	162	156	121	243	254
December	160	408	194	215	171	163	127	244	208
1944									
January	163	399	203	231	174	166	131	245	231
February	161	241	200	241	174	166	133	244	204
March	161	211	197	251	176	166	134	244	191
April	163	229	197	261	177	167	136	243	184
May	160	358	193	269	177	167	135	243	217
June	163	473	180	266	177	163	126	245	245
July	164	433	198	263	181	158	116	245	236

Wholesale Prices of Ammoniates

	Nitrate of soda per unit N bulk	Sulphate of ammonia bulk per unit N	Cottonseed meal S. E. Mills per unit N	Fish scrap, dried 11–12% ammonia, 15% bone phosphate, f.o.b. factory, bulk per unit N	Fish scrap, wet acidulated, 6% ammonia, 3% bone phosphate f.o.b factory bulk per unit N	Tankage 11% ammonia, 15% bone phosphate, f.o.b. Chicago, bulk, per unit N	High grade ground blood, 16–17% ammonia, Chicago, bulk, per unit N
1910–14	$2.68	$2.85	$3.50	$3.53	$3.05	$3.37	$3.52
1922	3.04	2.58	6.07	4.66	3.54	4.75	4.99
1923	3.02	2.90	6.19	4.83	4.25	4.59	5.16
1924	2.99	2.44	5.87	5.02	4.41	3.60	4.25
1925	3.11	2.47	5.41	5.34	4.71	3.97	4.75
1926	3.06	2.41	4.40	4.95	4.15	4.36	4.90
1927	3.01	2.26	5.07	5.87	4.35	4.32	5.70
1928	2.67	2.30	7.06	6.63	5.28	4.92	6.00
1929	2.57	2.04	5.64	5.00	4.69	4.61	5.72
1930	2.47	1.81	4.78	4.96	4.15	3.79	4.58
1931	2.34	1.46	3.10	3.95	3.33	2.11	2.46
1932	1.87	1.04	2.18	2.18	1.82	1.21	1.36
1933	1.52	1.12	2.95	2.86	2.58	2.06	2.46
1934	1.52	1.20	4.46	3.15	2.84	2.67	3.27
1935	1.47	1.15	4.59	3.10	2.65	3.06	3.65
1936	1.53	1.23	4.17	3.42	2.67	3.58	4.25
1937	1.63	1.32	4.91	4.66	3.65	4.04	4.80
1938	1.69	1.38	3.69	3.76	3.17	3.15	3.53
1939	1.69	1.35	4.02	4.41	3.12	3.87	3.90
1940	1.69	1.36	4.64	4.36	3.35	3.33	3.39
1941	1.69	1.41	5.50	5.32	3.27	3.76	4.43
1942	1.74	1.41	6.11	5.77	3.34	5.04	6.76
1943							
July	1.75	1.42	6.30	5.77	3.34	4.86	6.71
August	1.75	1.42	6.30	5.77	3.34	4.86	6.71
September	1.75	1.42	6.30	5.77	3.34	4.86	6.71
October	1.75	1.42	6.29	5.77	3.34	4.86	6.71
November	1.75	1.42	6.29	5.77	3.34	4.86	6.71
December	1.75	1.42	7.39	5.77	3.34	4.86	6.71
1944							
January	1.75	1.42	7.40	5.77	3.34	4.86	6.71
February	1.75	1.42	7.40	5.77	3.34	4.86	6.71
March	1.75	1.42	7.61	5.77	3.34	4.86	6.71
April	1.75	1.42	7.50	5.77	3.34	4.86	6.71
May	1.75	1.42	7.81	5.77	3.34	4.86	6.71
June	1.75	1.42	7.81	5.77	3.34	4.86	6.71
July	1.75	1.42	7.81	5.77	3.34	4.86	6.71
Index Numbers (1910-14 = 100)							
1922	113	90	173	132	117	140	142
1923	112	102	177	137	140	136	147
1924	111	86	168	142	145	107	121
1925	115	87	155	151	155	117	135
1926	113	84	126	140	136	129	139
1927	112	79	145	166	143	128	162
1928	100	81	202	188	173	146	170
1929	96	72	161	142	154	137	162
1930	92	64	137	141	136	112	130
1931	88	51	89	112	109	63	70
1932	71	36	62	62	60	36	39
1933	59	39	84	81	85	97	71
1934	59	42	127	89	93	79	93
1935	57	40	131	88	87	91	104
1936	59	43	119	97	89	106	121
1937	61	46	140	132	120	120	122
1938	63	48	105	106	104	93	100
1939	63	47	115	125	102	115	111
1940	63	48	133	124	110	99	96
1941	63	49	157	151	107	112	126
1942	65	49	175	163	110	150	192
1943							
July	65	50	180	163	110	144	191
August	65	50	180	163	110	144	191
September	65	50	180	163	110	144	191
October	65	50	180	163	110	144	191
November	65	50	180	163	110	144	191
December	65	50	211	163	110	144	191
1944							
January	65	50	211	163	110	144	191
February	65	50	211	163	110	144	191
March	65	50	217	163	110	144	191
April	65	50	214	163	110	144	191
May	65	50	223	163	110	144	191
June	65	50	223	163	110	144	191
July	65	50	223	163	110	144	191

Wholesale Prices of Phosphates and Potash**

	Superphosphate Baltimore, per unit	Florida land pebble 68% f.o.b. mines, bulk, per ton	Tennessee phosphate rock, 75% f.o.b. mines, bulk, per ton	Muriate of potash bulk, per unit, c.i.f. Atlantic and Gulf ports	Sulphate of potash in bags, per unit, c.i.f. Atlantic and Gulf ports	Sulphate of potash magnesia, per ton, c.i.f. Atlantic and Gulf ports	Manure salts bulk, per unit, c.i.f. Atlantic and Gulf ports[1]	Kainit, 20% bulk, per unit, c.i.f. Atlantic and Gulf ports[1]
1910–14	$0.536	$3.61	$4.88	$0.714	$0.953	$24.18	$0.657	$0.655
1922	.566	3.12	6.90	.632	.904	23.87	....	.508
1923	.550	3.08	7.50	.588	.836	23.32	....	.474
1924	.502	2.31	6.60	.582	.860	23.72	....	.472
1925	.600	2.44	6.16	.584	.860	23.72	....	.483
1926	.598	3.20	5.57	.596	.854	23.58	.537	.524
1927	.535	3.09	5.50	.646	.924	25.55	.586	.581
1928	.580	3.12	5.50	.669	.957	26.46	.607	.602
1929	.609	3.18	5.50	.672	.962	26.59	.610	.605
1930	.542	3.18	5.50	.681	.973	26.92	.618	.612
1931	.485	3.18	5.50	.681	.973	26.92	.618	.612
1932	.458	3.18	5.50	.681	.963	26.90	.618	.591
1933	.434	3.11	5.50	.662	.864	25.10	.601	.565
1934	.487	3.14	5.67	.486	.751	22.49	.483	.471
1935	.492	3.30	5.69	.415	.684	21.44	.444	.488
1936	.476	1.85	5.50	.464	.708	22.94	.505	.560
1937	.510	1.85	5.50	.508	.757	24.70	.556	.607
1938	.492	1.85	5.50	.523	.774	25.17	.572	.623
1939	.478	1.90	5.50	.521	.751	24.52	.570	.607
1940	.516	1.90	5.50	.517	.730	....	.573	....
1941	.547	1.94	5.64	.522	.779	25.55	.570	....
1942	.600	2.13	6.29	.522	.809	25.74	.205	....
1943								
July	.640	2.00	5.90	.503	.797	26.00	.188	....
August	.640	2.00	5.90	.503	.797	26.00	.188	....
September	.640	2.00	5.90	.503	.797	26.00	.188	....
October	.640	2.00	5.90	.535	.797	26.00	.200	....
November	.640	2.00	5.90	.535	.797	26.00	.200	....
December	.640	2.00	6.10	.535	.797	26.00	.200	....
1944								
January	.640	2.00	6.10	.535	.797	26.00	.200	....
February	.640	2.00	6.10	.535	.797	26.00	.200	....
March	.640	2.00	6.10	.535	.797	26.00	.200	....
April	.640	2.00	6.10	.535	.797	26.00	.200	....
May	.640	2.00	6.10	.535	.797	26.00	.200	....
June	.640	2.00	6.10	.471	.701	22.88	.176	....
July	.640	2.00	6.10	.503	.797	26.00	.188	....

Index Numbers (1910-14 = 100)

1922	106	87	141	89	95	99	....	78
1923	103	85	154	82	88	96	....	72
1924	94	64	135	82	90	98	....	72
1925	110	68	126	82	90	98	....	74
1926	112	88	114	83	90	98	82	80
1927	100	86	113	90	97	106	89	89
1928	108	86	113	94	100	109	92	92
1929	114	88	113	94	101	110	93	92
1930	101	88	113	95	102	111	94	93
1931	90	88	113	95	102	111	94	93
1932	85	88	113	95	101	111	94	90
1933	81	86	113	93	91	104	91	86
1934	91	87	110	68	79	93	74	72
1935	92	91	117	58	72	89	68	75
1936	89	51	113	65	74	95	77	85
1937	95	51	113	71	79	102	85	93
1938	92	51	113	73	81	104	87	95
1939	89	53	113	73	79	101	87	93
1940	96	53	113	72	77	....	87	....
1941	102	54	110	73	82	106	87	....
1942	112	59	129	73	85	106	84	....
1943								
July	119	55	121	70	84	108	82	....
August	119	55	121	70	84	108	82	....
September	119	55	121	70	84	108	82	....
October	119	55	121	75	84	108	83	....
November	119	55	121	75	84	108	83	....
December	119	55	125	75	84	108	83	....
1944								
January	119	55	125	75	84	108	83	....
February	119	55	125	75	84	108	83	....
March	119	55	125	75	84	108	83	....
April	119	55	125	75	84	108	83	....
May	119	55	125	75	84	108	83	....
June	119	55	125	66	74	95	80	....
July	119	55	125	70	84	108	82	....

Combined Index Numbers of Prices of Fertilizer Materials, Farm Products and All Commodities

	Farm prices*	Prices paid by farmers for commodities bought*	Wholesale prices of all commodities†	Fertilizer materials‡	Chemical ammoniates	Organic ammoniates	Superphosphate	Potash
1922.....	132	149	141	116	101	145	106	85
1923.....	142	152	147	114	107	144	103	79
1924.....	143	152	143	103	97	125	94	79
1925.....	156	157	151	112	100	131	109	80
1926.....	145	155	146	119	94	135	112	86
1927.....	139	153	139	116	89	150	100	94
1928.....	149	155	141	121	87	177	108	97
1929.....	146	153	139	114	79	146	114	97
1930.....	126	145	126	105	72	131	101	99
1931.....	87	124	107	83	62	83	90	99
1932.....	65	107	95	71	46	48	85	99
1933.....	70	109	96	70	45	71	81	95
1934.....	90	123	109	72	47	90	91	72
1935.....	108	125	117	70	45	97	92	63
1936.....	114	124	118	73	47	107	89	69
1937.....	121	130	126	81	50	129	95	75
1938.....	95	122	115	78	52	101	92	77
1939.....	93	121	112	79	51	119	89	77
1940.....	98	122	115	80	52	114	96	77
1941.....	122	130	127	86	56	130	102	77
1942.....	157	152	144	93	57	161	112	77
1943								
July.....	188	169	150	94	57	160	119	74
August....	193	169	150	94	57	160	119	74
September.	193	169	150	94	57	160	119	74
October...	192	170	150	95	57	160	119	78
November.	194	171	150	95	57	160	119	78
December..	196	173	150	96	57	171	119	78
1944								
January....	196	174	150	96	57	171	119	78
February..	195	175	151	96	57	171	119	78
March.....	196	175	151	97	57	173	119	78
April.....	196	175	152	96	57	172	119	78
May	194	175	152	97	57	175	119	78
June.....	193	176	151	95	57	175	119	69
July.....	192	176	152	96	57	175	119	74

* U. S. D. A. figures.

† Department of Labor index converted to 1910-14 base.

‡ The Index numbers of prices of fertilizer materials are based on original study made by the Department of Agricultural Economics and Farm Management, Cornell University, Ithaca, New York. These indexes are complete since 1897. The series was revised and reweighted as of March 1940 and November 1942.

[1] Beginning with June 1941, manure salts prices are F. O. B. mines, the only basis now quoted.

** The annual average of potash prices is higher than the weighted average of prices actually paid because since 1926 better than 90% of the potash used in agriculture has been contracted for during the discount period. From 1937 on, the maximum seasonal discount has been 12%.

REVIEWS

This section contains a short review of some of the most practical and important bulletins, and lists all recent publications of the United States Department of Agriculture, the State Experiment Stations, and Canada, relating to Fertilizers, Soils, Crops, and Economics. A file of this department of BETTER CROPS WITH PLANT FOOD would provide a complete index covering all publications from these sources on the particular subjects named.

Fertilizers

"Farm Fertility Facts for Continuous Cash Cropping," Ont. Agr. College, Guelph, Ont., N. J. Thomas.

"State Laboratory Fertilizer, Seed, and Ice Cream Report July-December, 1943," State Board of Agr., Dover, Del., Dec. 31, 1943.

"Tonnage of Different Grades of Fertilizer Sold in Delaware 1943," Agr. Exp. Sta., Dover, Del., C. E. Phillips.

"Analyses of Official Samples of Fertilizer Collected During 1943," State Board of Agr., Control Div., Topeka, Kans.

"Tonnage of Commercial Fertilizer Reported by Manufacturers As Shipped to Kansas During the Year 1943, by Counties," State Board of Agr., Control Div., Topeka, Kans., Jan. 1, 1944.

"Official Inspections 189," Agr. Exp. Sta., Orono, Me., Oct. 1943, Elmer R. Tobey.

"Tonnage of Different Grades of Fertilizer Sold in Michigan 1943," Soils Science Dept., Mich. State College, East Lansing, Mich.

"Effect of Nitrogen on Growth and Drouth Resistance of Jack Pine Seedlings," Agr. Exp. Sta., Univ. of Minn., St. Paul, Minn. T. Bul. 163, June 1943, Dwight W. Bensend.

"Nitrous Acid and the Loss of Nitrogen," Agr. Exp. Sta., Cornell Univ., Ithaca, N. Y., Memoir 253, Oct. 1943, J. K. Wilson.

"Fertilizer Recommendations for Vermont 1944-1945," Ext. Serv., Univ. of Vt., Burlington, Vt., June 1944.

Soils

"A Lysimeter Study of the Nitrogen Balance in Irrigated Soils," Agr. Exp. Sta., Univ. of Ariz., Tucson, Ariz., T. Bul. 102, May 15, 1944, H. V. Smith.

"Types and Distribution of Microorganisms in Some Florida Soils," Agr. Exp. Sta., Gainesville, Fla., Bul. 396, Jan. 1944, F. B. Smith and Owen E. Gall.

"A Laboratory Method for the Artificial Alteration of Aluminosilicates," Agr. Exp. Sta., State College Sta., Raleigh, N. C., T. Bul. 77, Dec. 1943, N. S. Hall.

"Cropping Systems and Soil Fertility," Agr. Exp. Sta., Okla. A. & M. College, Stillwater, Okla., Mimeo. Cir. M-121, May 1944, H. J. Harper and H. F. Murphy.

"Composts for Garden Soils," Ext. Serv., Ore. State College, Corvallis, Ore., E. Cir. 415, (Rev. Cir. 387), Sept. 1943, O. T. McWhorter.

"Terracing in South Carolina," Clemson Agr. College, Clemson, S. C., Cir. 251, Jan. 1944, C. V. Phagan.

"The Care and Maintenance of Terraces," Clemson Agr. College, Clemson, S. C., Cir. 254, Feb. 1944, C. V. Phagan.

"Saving the Soil—While Increasing Crop Production," Ext. Serv., Univ. of Tenn., Knoxville, Tenn., Agron. V. Cir. 2, May 1944, H. E. Hendricks.

"How and Where to Use Lime in Western Washington," Agr. Exp. Sta., State College of Wash., Pullman, Wash., V. Cir. 16, Feb. 1944, S. C. Vandecaveye and L. E. Dunn.

"Gypsum (Land Plaster) for Peas," Agr. Exp. Sta., State College of Wash., Pullman, Wash., V. Cir. 17, Feb. 1944, C. B. Harston, Verle G. Kaiser, and Glenn M. Horner.

"Investigations in Erosion Control and the Reclamation of Eroded Land at the Palouse Conservation Experiment Station, Pullman, Wash., 1931-42," U. S. D. A., Washington, D. C., T. Bul. 860, April 1944, Glenn M. Horner, A. G. McCall, and F. G. Bell.

Crops

"Small Grain Varietal Experiments for Southern Arizona," Agr. Exp. Sta., Univ. of Ariz., Tucson, Ariz., Bul. 191, Jan. 1944, A. T. Bartel.

"Experiments with the Transplant Onion Crop in California," Agr. Exp. Sta., Univ. of Calif., Berkeley, Calif., Bul. 682, Jan. 1944, Glen N. Davis and H. A. Jones.

"Factors Influencing the Yield, Composition, and Quality of Raisins," Agr. Exp. Sta., Univ. of Calif., Berkeley, Calif., Bul. 683, Jan. 1944, H. E. Jacob.

"Currants and Gooseberries," Hort. Exp. Sta., Vineland Sta., Ont., Bul. 440, April, 1944, W. J. Strong.

"Addresses, Annual Convention Ontario Crop Improvement Association," Ont. Dept. of Agr., Crops, Seeds, and Weeds Branch, Toronto, Ont.

"Addresses and Proceedings, Ontario Crop Improvement Association," Ont. Dept. of Agr., Toronto, Ont., Feb. 1944.

"Vegetables for Victory," Ext. Serv., Colo. State College, Fort Collins, Colo., Cir. WFA-G2.

"Vegetable Gardening for Victory," Ext. Serv., Univ. of Del., Dover, Del., Wartime E. Folder 5 (Rev. March 1944), Feb. 1943, E. P. Brasher.

"1943 Report Florida Agricultural Extension Service," Ext. Serv., Univ. of Fla., Gainesville, Fla.

"Sweet Potatoes—A War Food and Feed Crop," Agr. Ext. Serv., Univ. of Fla., Gainesville, Fla., Cir. 77, April 1944, J. Lee Smith.

"Oats on Florida Farms Grow 50 Bushels to the Acre," Agr. Ext. Serv., Univ. of Fla., Gainesville, Fla., Cir. 78, June 1944.

"Growing 'Manure' with Blue Lupines in Florida," Ext. Serv., Univ. of Fla., Gainesville, Fla., Cir. 79, June 1944, J. Lee Smith.

"Eight Point Milk Production Program," Agr. Ext. Serv., Univ. System of Ga., Athens, Ga., E. Cir. 319, Feb. 1944.

"Corn in Georgia," Ext. Serv., Univ. System of Ga., Athens, Ga., E. Cir. 320, March 1944, E. D. Alexander.

"Establishing the Coastal Bermuda Grass Nursery," Ga. Coastal Plain Exp. Sta., Tifton, Ga., Mimeo. 27, April 24, 1944.

"Production and Storage of Sweet Potatoes for the Seed-Piece Method of Planting," Ga. Coastal Plain Exp. Sta., Tifton, Ga., Mimeo. 28, May 1944.

"The Purdue 44 Muskmelon," Agr. Exp. Sta., Lafayette, Ind., Cir. 295, April 1944, John D. Hartman and F. C. Gaylord.

"A New Era in Oat Production," Agr. Exp. Sta., Purdue Univ., Lafayette, Ind., Cir. 296, June 1944, R. R. Mulvey.

"Garden Guide," Ext. Serv., Iowa State College, Ames, Ia., Pamphlet 80, Jan. 1944.

"Potato Production in Kansas," Agr. Exp. Sta., State College, Manhattan, Kans., Bul. 322, Feb. 1944.

"Kansas Corn Tests, 1943," Agr. Exp. Sta., State College, Manhattan, Kans., Bul. 323, Jan. 1944, R. W. Jugenheimer, A. L. Clapp, C. D. Davis, and C. R. Porter.

"Studies with the Gladiolus in South Louisiana," Agr. Exp. Sta., Univ. of La., Baton Rouge, La., Bul. 372, Jan. 1944, W. D. Kimbrough.

"How Can I Get My Haying Done in Wartime," Ext. Serv., Univ. of Me., Orono, Me., 1944.

"Food and Forest Products for a Nation at War," Ext. Serv., Univ. of Me., Orono, Me., Cir. 197, April 1944.

"The Identification of Plum Varieties from Non-Bearing Trees," Agr. Exp. Sta., Mass. State College, Amherst, Mass., Bul. 413, March 1944, Lawrence Southwick and A. P. French.

"Potatoes in Home Gardens," Ext. Serv., Mass. State College, Amherst, Mass., E. Leaf. 231, Feb. 1944, Alden P. Tuttle.

"Starting Vegetable Plants in the Home," Ext. Serv., Mass. State College, Amherst, Mass., E. Leaf. 232, Feb. 1944, Alden P. Tuttle.

"Studies of Pot-Binding of Greenhouse Plants," Agr. Exp. Sta., Mich. State College, East Lansing, Mich., T. Bul. 191, March 1944, A. T. Knight.

"Michigan Garden Guide," Ext. Serv., Mich. State College, East Lansing, Mich., E. Bul. 258, March 1944.

"Winter Behavior of Strawberry Plants," Agr. Exp. Sta., Univ. of Minn., St. Paul, Minn., Bul. 375, March 1944, W. G. Brierley and R. H. Landon.

"Make Your Hay by This Yardstick," Ext. Serv., Univ. of Minn., St. Paul, Minn., E. Pamph. 136, May 1944.

"Home Orchards in Mississippi," Agr. Exp. Sta., Miss. State College, State College, Miss., Bul. 393 (Rev. of Bul. 350), Sept. 1943, Troy H. Jones and T. E. Ashley.

"Hybrid Corn Test, Stoneville, 1943," Agr. Exp. Sta., State College, Miss., S. Sheet 371, Feb. 1944, P. W. Gull.

"Pasture vs. Dry Lot for Fattening Cattle," Agr. Exp. Sta., Univ. of Nebr., Lincoln, Nebr., Bul. 354, R. R. Thalman.

"Fifty-Fourth Annual Report," Agr. Exp. Sta., N. Mex. College of A. & M., State College, N. Mex.

"1944 Canning Crops," Agr. Exp. Sta., Geneva, N. Y.

Official Variety Tests 1943," Agr. Exp. Sta., State College, Raleigh, N. C., Bul. 343, May 1944, R. P. Moore, J. A. Rigney, G. K. Middleton, and L. S. Bennett.

"Top-Working and Bench-Grafting Walnut Trees," Agr. Exp. Sta., Wooster, Ohio, Sp. Cir. 69, March 1944, L. Walter Sherman and C. W. Ellenwood.

"Ohio's Forest Resources," Agr. Exp. Sta., Wooster, Ohio, Forestry Publ. 76, Jan. 1944, Oliver D. Diller.

"Weeping Lovegrass in Oklahoma," Agr. Exp. Sta., Stillwater, Okla., Bul. 281, June 1944, Hi W. Staten and Harry M. Elwell.

"Reseeding Eastern Oregon Summer Ranges," Agr. Exp. Sta., Ore. State College, Corvallis, Ore., Sta. Cir. 159, Jan. 1944, G. D. Pickford and E. R. Jackman.

"Broccoli Growing and Marketing," Ext. Serv., Ore. State College, Corvallis, Ore., E. Cir. 411, (Rev. of Cir. 262), June 1943, A. G. B. Bouquet.

"Greenhouse Management," Ext. Serv., Ore. State College, Corvallis, Ore., E. Cir. 418, Nov. 1943, A. G. B. Bouquet.

"Production and Marketing of Onions," Ext. Serv., Ore. State College, Corvallis, Ore., E. Cir. 419 (Rev. of Cir. 312), Nov. 1943, A. G. B. Bouquet.

"Celery Growing and Marketing," Ext. Serv., Ore. State College, Corvallis, Ore., E. Cir. 421, (Rev. of Cir. 309), Nov. 1943, A. G. B. Bouquet.

"Brussels Sprouts," Ext. Serv., Ore. State College, Corvallis, Ore., E. Cir. 422, (Rev. of Cir. 279), Dec. 1943, A. G. B. Bouquet.

"Red and Black Raspberries," Ext. Serv., Ore. State College, Corvallis, Ore., E. Cir. 424, Feb. 1944.

"The Blueberry in Oregon," Ext. Serv., Ore. State College, Corvallis, Ore., E. Cir. 428, March 1944, Henry Hartman.

"South Dakota Corn Performance Test, 1943," Agr. Exp. Sta., S. Dak. State College, Brookings, S. Dak., Cir. 50, March 1944, J. E. Grafius and E. R. Hehn.

"Twenty-Eighth Report of Cooperative Extension Work in Agriculture and Home Economics, State of Vermont, for the Fiscal Years Ending June 30, 1942, and June 30, 1943," Ext. Serv., Univ. of Vt., Burlington, Vt., Bul. 28, Jan. 1944, J. E. Carrigan.

"The 1943 Virginia Corn Performance Tests," Agr. Exp. Sta., Blacksburg, Va., Bul. 358, Jan. 1944, M. H. McVickar.

"4-H Project Manual Vegetable Gardening," Ext. Div., Blacksburg, Va., Cir. E-376, March 1941.

"4-H Project Manual Corn Production," Ext. Div., Blacksburg, Va., Cir. E-379, March 1944.

"Produce High Quality Hay," Ext. Serv., Va. Polytechnic Inst., Blacksburg, Va., Cir. 381, May 1944.

"What's New in Farm Science," Agr. Exp. Sta., Univ. of Wis., Madison, Wis., Bul. 461, Dec. 1943.

"Currants & Gooseberries in Wisconsin," Ext. Serv., Univ. of Wis., Madison, Wis., Stencil Cir. 177 (Rev. Jan. 1944), May 1933, James G. Moore.

"Growing Grapes at Home," Ext. Serv., Univ. of Wis., Madison, Wis., Stencil Cir. 235, Feb. 1944, James G. Moore.

"Growing Strawberries in Wisconsin," Ext. Serv., Univ. of Wis., Madison, Wis., Stencil Cir. 237, Jan. 1944, James G. Moore.

"Sugar Beets in Wisconsin," Ext. Serv., Univ. of Wis., Madison, Wis., Stencil Cir. 238, Feb. 1944.

"Maturity and Handling of Green-Wrap Tomatoes in Mississippi," U. S. D. A., Washington, D. C., Cir. 695, March 1944, J. M. Lutz.

"Judging Condition and Utilization of Short-Grass Ranges on the Central Great Plains," U. S. D. A., Washington, D. C., F. Bul. 1949, March 1944, David F. Costello and George T. Turner.

"Blueberry Growing," U. S. D. A., Washington, D. C., F. Bul. 1951, May 1944, George M. Darrow and R. B. Wilcox.

"Onion-Set Production," U. S. D. A., Washington, D. C., F. Bul. 1955, May 1944, J. C. Walker, W. C. Edmundson, and H. A. Jones.

"Responses of Beans (Phaseolus) and Other Legumes to Length of Day," U. S. D. A., Washington, D. C., T. Bul. 867, April 1944, H. A. Allard and W. J. Zaumeyer.

"Guides for Cutting Timber in the Northeast," U. S. D. A., Washington, D. C., AWI-90, April 1944.

"Good Seed Potatoes Give Best Results," U. S. D. A., Washington, D. C., AWI-88, Feb. 1944.

"Soil Conservation Aids Soybean Production," U. S. D. A., Washington, D. C., AWI-92, April 1944.

"Making Grass Silage by the Wilting Method," U. S. D. A., Washington, D. C., Leaf. 238, 1944, T. E. Woodward.

Economics

"Peanuts: A War Crop on Alabama Farms," Agr. Exp. Sta., Auburn, Ala., Agr. Econ. Mimeo. 1, March 1943, Albert H. Harrington, Phillip E. Jones, and William F. Lagrone.

"California Farms: To Buy or Not to Buy," Agr. Exp. Sta., Univ. of Calif., Berkeley, Calif., Cir. 358, March 1944, R. L. Adams.

"Buying a Farm in Colorado, Agr. Exp. Sta., Colo. State College, Fort Collins, Colo., Bul. 485, April 1944, R. T. Burdick, Alvin Kezer, A. M. Binkely, and R. C. Tom.

"Indiana Crops and Livestock," Dept. of Agr. Statistics, West Lafayette, Ind., Annual Crop Summary 1943, Dec. 1943.

"The Proper Size and Location of Corn Stabilization Stocks," Agr. Exp. Sta., State College, Ames, Iowa, R. Bul. 321, Aug. 1943, Geoffrey Shepherd and David G. Paterson.

"Adjusting Crop Acreages for War Production to the Soil Resources of Iowa," Agr. Exp. Sta., State College, Ames, Iowa, R. Bul. 324, Nov. 1943, A. J. Englehorn and A. C. Bunce.

"Planning for Post-War Agriculture in Louisiana," Agr. Exp. Sta., Baton Rouge 3, La., D. A. E. Mimeo. Cir. 39, Feb. 15, 1944.

Potash for War Food

(*From page* 14)

that potash in mixed goods varies widely in line with official recommendations based on crop and soil requirements. To the same degree and for the same reason, nation-wide average ratios of the three plant-food elements —nitrogen, potassium, and phosphorus —have no agronomic significance.

Danger lies in their possible acceptance as possessing some desirable characteristics pertinent to the war-food program. To be sure, there has long persisted the need for the reduction in the number of grades and the removal of restrictions on interstate distribution. Great relief in both respects has resulted from war-agency initiation, a simplification that surely will not be abandoned when the directives imposing it are no longer in effect. To date, this simplification where made solely to eliminate grades no longer useful has still adhered to the scientific basis of crop nutrition; but it is obvious that there is a limit beyond which it cannot go without the abandonment of that basis.

The total supply of agricultural potash is allocated to the fertilizer industry for retail distribution to the farmers, either as mixed goods or as materials. In past years, it is estimated some 10 per cent of agricultural potash customarily has been retailed for use by farmers for side-dressing or home-mixing. In recent years such mixtures as 10-0-10 have grown in popularity for side-dressing, and currently it is reported that home-mixing has been largely abandoned, among other reasons due to scarcity of farm labor. There seems little doubt that because of past acute apprehension over the inadequacy of potash supplies there has been widespread reluctance to retail potash as a material, a situation plainly contrary to war agency instructions, which now may be corrected. However, based on the record as it now stands, the conclusion is obvious that if the estimated 10 per cent approximates the total of normal retail potash sales as materials, sales throughout the past winter months were much below that rate.

The question has been frequently raised—will the supplemental allocation for Period Three be delivered in time for use during the spring season? This question ignores the fact that if Period Three deliveries in one year are received too late for use in the spring of that year, they are held in storage for use in the fall and that any such tonnages thereupon become a part of the year's supply. Period Three deliveries, known in the trade as the "spot season," are thoroughly well understood as a familiar trade custom of long standing concerning which experience should provide a ready answer.

The Discount Season

The potash industry, it is recalled, operates on a daily and not a seasonal basis. Every effort is made to effect deliveries uniformly throughout the year, and the existing discount system is designed to promote that objective. An explanation of and justification for this discount system is to be found in the Department of Commerce Report, "The Potash Industry," by Willard L. Thorp and Ernest A. Tupper, pp. 87-8, stating its purpose to be: "(1) to encourage purchasers to make advance commitments, thus permitting the producers to plan their production schedules in the light of the anticipated requirements by the fertilizer industry, (2) to provide for the flow of potash in 'substantially equal monthly quantities' during the entire discount period." In effect, discounts operate as payments to purchasers for storage costs, otherwise imposing on the producers the enormous task of storing the tonnages involved in a year's output, and, what is even worse, creating a traffic congestion during the shipping season impossible to cope with.

The potash industry is confronted by war-time shipping problems strictly analogous to those facing the fertilizer industry respecting the seasonal delivery of mixed goods; for the relief of the fertilizer industry the farmers are now urged by government to accept month by month delivery. The record of potash deliveries shows that they customarily reach their maxima in December-January and their minima in April-May, with substantial improvement in recent years with respect to more uniform delivery. For example, during 1940, the spread between the

maximum and minimum was 55,000 tons K_2O, while during 1943 it was reduced to 35,000 tons K_2O. Obviously, further gains yet remain to be made before maximum efficiency is attained in this particular.

The orderly furnishing of box cars on the sidings of the potash refineries is a constant problem, fortunately so far not having reached that critical stage at one time feared. From the Carlsbad, New Mexico, potash-producing center alone, there are being shipped out some 1,300,000 tons of potash salts per annum. With capacity loadings of 50 tons per car, this means 26,000 cars per annum or an average of some 2,200 cars per month. This service is provided by the Santa Fe Railroad over a spur line, which testifies to the proficiency of that company in being able to maintain a day by day traffic of such dimensions under present war conditions. A similar problem is confronted at the California production center. All of this adds up to the essentiality of a year-round, planned delivery of potash salts with the avoidance of a congested shipping season.

The Problems Ahead

Coming now to the problems that lie ahead, on the foundation of experience gained in planning for the crop year of 1943-44, it should be possible to proceed with the task for 1944-45 with full realism. The consensus of opinion appears to be that there will be no diminution of food demands. The contrary seems to be the prospect. It follows that the demands on the American farmer will pursue this trend and there is no reason to consider the possibility that he will not respond with the utmost of effort that he can bring to bear. Those suggesting increased acreages to be plowed up have been silenced by the reminder of the dust bowls following our last attempt at that procedure, futile at best with labor and farm machinery supplies inadequate to the optimum cultivation of the acreages already plowed. Labor appears a major bottleneck; in other words, the requirement is intensive cultivation of our better soils in the light of our best knowledge of scientific agriculture including the optimum use of plant-food mixtures in the most efficient ratio of one to another as demonstrated and recommended by state and federal authorities. This calls for a different approach from that of last year; namely, what is recommended—not, what can we get by with?

Since mixtures of plant-food are the farmers' preference, emphasis again will be put on what tonnage can be produced. The fertilizer year just closed will be a measure, the best measure available as based on performance resulting from an all-out effort to produce the maximum tonnage with existing plants, supplies, and labor. Is there room for improvement, pending relaxation of present restrictions on most of the elements that enter into plant operation and distribution of products?

Following the surrender of the Hitlerites we are led to believe that there will be the inauguration of the transition period with the gradual release of labor and supplies from industries more intimately related to the military. When this happens, and how quickly thereafter its effects will be registered on other business, is anybody's guess, optimism impelling the faith that it will happen not later than next winter and that thereafter the benefits will be realized in time to make themselves felt in the relaxation of present restrictions on increased production during the remaining months of 1944-45. To gauge this hoped-for expansion in terms of mixed-goods tonnage calls for extreme wisdom if we are not to be misled again into confusing the theoretical with the practical, what is needed with what can be produced.

By contrast, the figures on potash supplies released from authoritative sources are based squarely on the pro-

duction records, the only realistic base. Entering therein are allowances injected in the name of conservativeness. They are assured minima, not hoped-for maxima. They have no reference to what is needed, but only to what can be produced. Such is the basis of the foregoing figures expressing the supply to be derived from five domestic producers. It is common knowledge that this represents a more than two-fold increase since 1939, resulting from an expansion program promptly and courageously inaugurated by the American producers on the outbreak of European hostilities and slowed-down, but not stopped, only by government restrictions on materials of construction.

This doubling of production capacity has been privately financed, and it is clear that the motive was public service—the promotion of the war effort through providing more nearly adequate supplies of a commodity described by the military as "strategic, essential, and critical." Enhanced wartime profits are eliminated as the objective, since there has been no increase in the wholesale price of 60 per cent muriate, that preferred carrier representing 78 per cent of the total, still being quoted at the pre-war discount price of 47.1¢ per unit K_2O, and the entire output of the potash industry being sold on the wholesale basis. In relation to other wholesale prices, this price represents an index number of 66 as compared to 150 for commodities in general (basis 1910–14 = 100).

Freight charges that are absorbed by the producers have undergone an increase with enforced all-rail, due to the elimination of water, shipment. Facing the industry are the post-war hazards of potash imports with no present clue to methods, quantities, or prices. This outstanding performance in behalf of the American agricultural and chemical industries and, through them, the Nation's war effort, last year was obscured by a fictitious potash shortage, creating a false impression of failure in meeting an emergency where the facts registered a spectacular success.

Warranted Speculation

Now introducing some speculation, pretty completely excluded heretofore in this discussion of the potash supply phase of this subject, mention has been made of the possible relaxation in the stringency of labor supply following the ending of the European phase of the war and the resultant possibility of an expanded mixed-goods output during 1944-45. The same speculation applies to those sections of the chemical industry now using 100,000 tons K_2O, many of whose products have a direct tie-in with the military and for which the demand could be expected to decline with that for other military supplies to which the prospective release of labor is ascribed. While it is easy to foresee a very substantial release (now indicated by the records as already taking place) of potash from this greatly expanded chemical use, with the distinct prospect of its favorable effect on next year's supply for agricultural use, to attempt a more definite statement on time and amount again would be futile. However, the conclusion seems warranted that coincident with any release of labor permitting an expanded output of mixed goods there will be a release of potash from chemical use to agricultural use, to which may be added the observation that the chemical uses most vulnerable to this change involve some 30,000 tons K_2O in the form of high-grade muriate.

Adding the drastically-discounted speculative to the practically assured increments in supplies, there is the prospect of 750,000 tons K_2O for agricultural use during the fertilizer year, 1944-45, a figure recommended for consideration where speculation is in order. Applied to mixed goods it would provide a 7.5 per cent K_2O average for 10 million tons, 8.3 per cent for 9 million tons and 9.3 per cent for 8 million tons. If the estimated 10 per cent formerly retailed as potash materials is

again offered, some 75,000 tons K_2O should be made available for direct application during 1944-45. This liberation of supplies will be welcomed particularly by the dairy and livestock interests of the South where the development and maintenance of improved pastures, dependent for their success on the liberal use of potash, is making such spectacular headway.

From the speculative viewpoint, interesting figures are being presented showing the Nation's plant-food requirements were the amounts used in agriculture ample for maximum crop production, figures easily derived and unquestioned. They are scarcely pertinent to the present discussion, however, for they are clearly beyond the realm of war-time production expansion. Confusing these optima with war-time attainable goals, a danger to be avoided, easily leads to the concept of deficits in supply, while as a matter of fact the plant-food supplies at hand may approximate war-time capacity to distribute by present methods.

Should distribution capacity prove the bottleneck due to shortages of labor, bags, and other essentials, it would be unfortunate indeed since the farmer now has the greatest purchasing power in agricultural history with fewer other commodities, to which his budget is customarily applied, available for purchase. Mehring and Shaw, of the U. S. Department of Agriculture, recently have re-examined, with elaborations, that 30-year-old economic concept of the relationship between farm income and fertilizer purchase and have found that the parallelism has continued to hold and with remarkable precision. On that basis the conclusion seems inescapable that at the present high farm-cash level, the farmer is in a position to buy his fertilizers on the basis of their plant-food content instead of their price per ton as has been his tendency in leaner years, according to a frequently expressed opinion.

The conclusion seems warranted in view of the foregoing, that the plant-food industries are now fully justified in their return to the scientific basis of potash use in crop nutrition as laid down by the agronomists, formerly observed with general adherence thereto but last year abandoned to a very considerable degree under the dual misapprehension that the potash supply would be less and the mixed goods output would be more than was actually the case. Only by so doing can the Nation's war-food program be promoted with maximum efficiency.

The Need for Borax on Fourteen Crops

(*From page* 19)

this case. These symptoms were not as severe as the death of the seedling which has been obtained in other experiments on the same soil.

Red Clover—A marked size and stature response to boron was obtained with red clover. The actual symptoms of boron deficiency, however, were not conspicuous or outstanding. Without borax almost all of the leaves of the plant became characteristic lemon yellow colored (the same color as has been observed in boron-deficient alfalfa). Normal leaf markings were completely obscured on all leaves. Without borax some of the leaves were streaked, some had green veins with much yellow between, while others had the reverse coloring. In either case, leaf veins were more prominent than usual. Thus the yellow streaking, due to boron deficiency, was parallel to the leaf veinings. These streaking symptoms were noticeable only on close inspection, but they

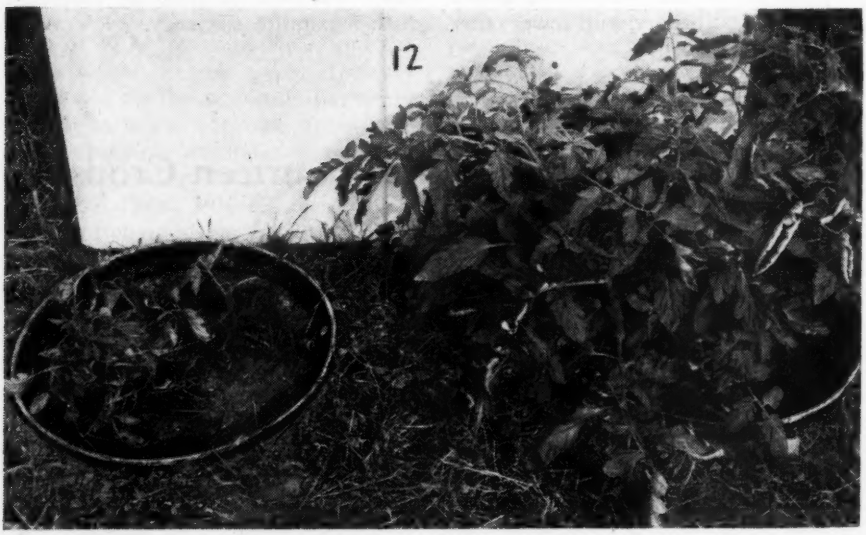
were better than yellowing alone as a basis for diagnosis of boron deficiency of red clover in farm fields. With borax, both the yellowing and streaking were fully corrected. The possibility that less severe boron deficiency of red clover may cause a "yellow top" condition similar to deficient alfalfa is not excluded, but in this instance all of the plant leaves were affected with "yellows." This deficiency was also more severe than that commonly reported to be responsible for lack of red clover seed.

Ladino Clover—Ladino likewise responded markedly to borax. Without it, the symptoms were much like red clover, the characteristic yellowing was observed, and normal leaf markings were obscured. Practically all leaves were affected. The deficiency was too severe for just the top leaves to be colored. Veinal and interveinal yellow streaking of a few leaves was also observed, similar to that noted with red clover, the rest of the leaf being a normal green color. Borax fully corrected these different types of leaf yellowing. Here again a "yellow top" condition was not obtained, but it seems likely that the right degree of deficiency may produce it.

Careful inspection would be required to detect signs of boron deficiency in fields of ladino and red clovers since there are other causes for legume leaves becoming a lemon yellow color. Only the interveinal and veinal yellowing would seem to serve well for diagnosis of this deficiency.

Timothy—This crop was in its first year from seeding and showed little, if any, response to borax. It was less affected by boron deficiency than any other crop grown in these experiments. However, since it is a long-lived perennial, it may later show some deficiency.

Sweet Corn (Var. Golden Bantam)—Sweet corn responded very markedly to borax. Without it, prominent symptoms were observed. Longitudinal streaks of yellow tissue in the leaves were the first and most obvious. The streaks first appeared to be water-soaked, then they bleached and died. From a distance, the symptom looked somewhat like magnesium deficiency, but on close inspection, the streaks were not continuous nor did they have regular edges. They appeared much more



Tomato transplants—note the extreme dwarfing and dieback due to boron deficiency (left). With borax, normal growth was attained (right).

crudely fashioned than magnesium deficiency streaks. Chlorophyll was completely missing in them. Similar results of boron deficiency are also mentioned by Chandler in Maine, but he did not describe them.

Deficient leaf tips tended to die and turn brown. Sometimes also the dead leaf tips coiled in a longitudinal direction into a tube the diameter of a lead pencil. The new leaves were usually first affected. The tassel in these experiments failed to form. The ear grew but produced no silk and therefore no grain, although it had husks in normal fashion. Severe deficiency symptoms thus include leaf streaks, coiled leaf tips, lack of tassel, and lack of silk and grain. With borax, normal plants developed.

Tomatoes (Var. Marglobe)—Tomatoes responded markedly to boron. Without borax, the transplants remained about as tall as when set. New growth started feebly, became dirty green or pale yellow, and died. Plants changed from a healthy green to a dirty pale green, the stalks increasing somewhat in diameter but not in length. No fruit or blossoms were produced, although the dwarf plants hung onto life most of the summer before they died.

With borax, the plants were normal, flowered, and set a prolific crop of fruit. Boron deficiency was thus clearly responsible for lack of tomato flowers and fruit. Other signs of deficiency important to the grower, such as susceptibility to disease, probably remain to be produced.

Cabbage (Var. Golden Acre)—Cabbage likewise responded markedly to borax. Without it the transplants became a stump with only a few rudimentary outside leaves having brown edges. These brown edges had a rotten appearance and the cabbage failed to head. The inner leaves which tried to grow became crude stumps of leaf petioles with dead brown edges. The growing tip became brown, rotten, and completely failed to develop. Eventually the deficient transplants died without making any appreciable growth. With borax, good heads of cabbage were formed in normal fashion. These deficiency symptoms were more severe than the internal discoloration of the cabbage head usually reported.

Broccoli—A marked response to borax was obtained with broccoli. Without it there was almost a complete lack of edible buds. Eventually the plant grew an excessive amount of leaves and finally succeeded in producing some flower stalks. However, these were abortive and no seed formed, merely naked pedicels where the seed pods should have been. No yellowing was noted although the possibility of it should not be excluded.

With borax, the growth was vigorous, flower stalks formed early without any excessive leafy growth. A good supply of edible buds was produced, and these later developed considerable seed. With borax, the broccoli grew in the normal fashion. Cauliflower shows similar field response in Scotland.

Oats—Oats responded to boron in these experiments only in terms of the yield and quality of grain. Without borax, 14 gms. of light weight grain per pot were obtained; with borax, 35 gms. of heavy grain. Borax-treated oats were almost twice as heavy per unit of volume and germinated 93 per cent compared with 51 per cent without borax. Borax seemed to have no appreciable effect on the size, color, or vigor of these oat plants until the grain came to approximately the milk stage. The deficient grain withered and aborted, while that receiving borax was well filled.

Similar observations in replicated field plots have been made once before by the writers. All evidence accumulated to date seems to show that empty heading of oats, which sometimes occurs in Vermont fields, is due in part at least to lack of boron in the fertilizer.

Lettuce (Var. Hansen)—Lettuce also responded markedly to borax. Without it, the seedlings grew about two inches high, became the charac-

teristic yellow, or pale green, and died. No seed was produced. With borax, normal plants developed, headed in the normal fashion, flowered, and then set a good crop of seed. Borax clearly was necessary for formation of flowers and seed. Further efforts will be required to obtain symptoms of lesser deficiency arresting growth midway between the death of seedlings and flowering. Milder symptoms would be more apt to occur in ordinary gardens and appear to be causing some losses to Vermont growers.

Beets (Var. Detroit dark red)—Beets responded markedly to borax. Without it, the seedlings grew straw colored and died when less than two inches high. Death of seedlings was again the deficiency symptom obtained. With borax, plants were normal. This deficiency was much more severe than that which produces the scabby cankers and heart rot of the root commonly described in literature.

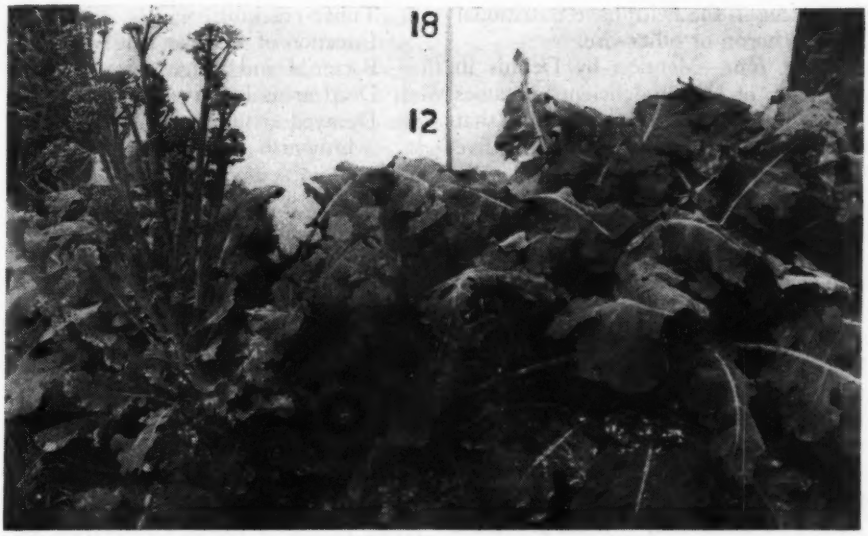
Other Nutritional Possibilities

There is a real possibility that stem-end browning, net necrosis, leaf roll, and ring-rot diseases of the potato, as well as blackening of cooked tubers, are nutritional diseases, or that susceptibility to them depends on nutritional factors. There is also a good possibility that bitter pit of apples is a nutritional disease regardless of failures to date to correct it with fertilizers. Nutritional investigations are being made at the Vermont Station to discover practical remedies for the diseases that so badly baffle potato growers. Present measures are not adequate because in spite of all that has been done to tuber-unit, index, and isolate seed potato plots, potato diseases are increasing and becoming more troublesome. In fact, in 1943 there was more net necrosis than ever before in some Vermont lots entered for certification, a 50 per cent infection in one and 15-30 per cent in others. Ring rot has invaded the Northeast before other older problems are well solved.

Potato growers need research help and need it badly. Nutritional research has an advantage over many other types because positive results once obtained can be directly put into effective field practice. Also many good crop varieties are losing ground because of diseases to which they have become susceptible. A new and resistant variety eventually is bred, in a short time likewise breaks down, and this requires more breeding. The degradation and breeding process goes on and on. The real remedy may be nutritional, the use of proper fertilizers to replace those plant-food elements lost by leaching and removed by crops from the soil. If the fertility could be replaced, much breeding work might well be avoided, and food crops with better nutritive quality could be produced. The Green Mountain potato, for example, is now going down hill fast due to susceptibility to disease.

Stem-End Browning—Chandler recently reported a brown coloration in potato tubers resulting from boron starvation in sand cultures. It was identical in appearance with the "stem-end browning" disease of the potato (2). There are many who will tend to doubt that boron is the answer to stem-end browning until it is demonstrated in field experiments. To the writers, this finding is not surprising, since they obtained the same color of browning affecting nearly all of the tuber tissues as a result of more severe boron starvation. Although our results were not the same as those of Chandler, our findings and experience tend to support him.

The work of Dennis in Scotland gives further support (3). Boron corrected a localized browning generally at the heel end of the tuber. "At the heel end" from Dennis means the same as "stem-end," as we understand it. It is highly desirable to determine whether or not stem-end browning is corrected by borax in the field. That is not likely to be as simple as it sounds because the field use of borax does not guarantee its availability to the crop



Broccoli—with borax (left), broccoli flowered profusely in normal fashion; without, it produced many leaves but failed to produce edible buds or flowers until late in fall. Buds were then abnormal and undesirable.

in the podzol soil region. Soils in some fields fix large amounts of boron out of reach of the crop, and field soils are often very spotty in their boron-fixing capacity. Hence, a number of trials on each soil would be needed with different rates and different placements of boron in the plant root zone to determine whether correction of stem-end browning could be obtained. Of course, there might also be other nutritional causes for the same sort of brown condition.

Leaf Roll and Net Necrosis—In each of the past two growing seasons an apparently non-parasitic, leaf-roll condition of the potato has been produced at the Vermont Station by extreme phosphorus starvation on a phosphorus-fixing soil and was corrected with phosphorus (6). The leaf roll resulting from extreme phosphorus starvation was indistinguishable from that present in our farm fields. Dr. Lutman, Pathologist, without knowledge of the fertilizer treatments, would have rogued out the phosphorus-starved plants as virus leaf roll had he encountered them in a farm field. Until we can learn more about it, we think that we should adopt the term, "apparently non-parasitic leaf roll" as has been suggested by Dennis. In Scotland, it is boron deficiency that sometimes produces leaf roll that is rogued out of the fields.

In the boron-deficiency experiment with potatoes described in this paper, an upward rolling of potato leaves was obtained and corrected with borax. Leaves, however, were muddy green in color, readily distinguishable from the virus leaf roll commonly prevalent in our farm fields. Our experiments, however, would not exclude the possibility of a leaf roll due to boron deficiency identical with virus leaf roll, at least in appearance.

Net necrosis tubers have repeatedly produced leaf roll plants in our experiments under ordinary field conditions, confirming again this commonly accepted fact. "Spindle sprout" potatoes also have repeatedly produced a typical virus leaf roll condition in field experiments, as some growers have come to suspect.

Further experiments are planned to try to find out if potato leaf roll, net necrosis, and stem-end browning, as

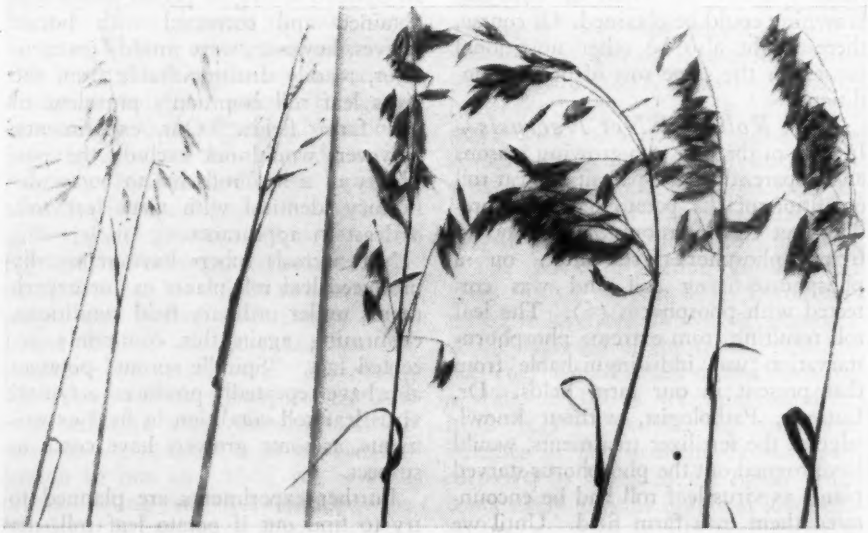
they occur in the field, have nutritional aspects, boron or otherwise.

Ring Rot—Mention by Dennis in Scotland of boron-deficient potatoes with a burst surface brings to mind that we obtained some similar tubers five years ago in a pot experiment. We caused it by boron starvation on a boron-fixing soil. Tubers with similar appearing breaks or cracked surfaces are pictured in Maine Ext. Bul. 286, "Potato Ring Rot."

We do not know that there is any relation whatever between ring rot and boron deficiency. However, since rots of sugar beets, turnips, celery, and other crops are due to boron deficiency, it is interesting to compare boron deficiency and ring-rot symptoms as described by Bonds and Wyman of Maine. Some characteristics common to both are:

Leaves rolled upward
Leaves mottled (chlorotic)
Leaves yellow or pale green
More or less wilting
Increase in dry weather
Tops of plants injured first
Death of whole or part of a plant
Tuber affection without the top of the plant showing symptoms
Tuber cracking
Infection of vascular ring
Bacterial and fungous invaders
Dead areas in leaves
Decayed tissues yellowish or brownish in color

Practically all of the symptoms of potato ring rot are very close to those known and expected in the potato from relatively severe phases of boron starvation, particularly those phases of boron deficiency corresponding to yellow top of alfalfa. Of the symptoms, only the contagious nature of ring rot would serve well to distinguish it from certain phases of boron deficiency. While the extreme similarity may be just a coincidence, experiments should be undertaken to see if boron fertilization reduces plant susceptibility to ring rot, or has any antiseptic action against the spread of potato ring rot, as it seems to have against early blight. Such experiments would seem easy; but to be conclusive, they will involve a considerable number of trials because of the possible poor plant availability of borax on soils in the podzol region.



Oats—no borax (left); with borax (right). Boron-deficient heads were empty; with borax they were well filled.

Boron deficiency may well account for one or more of our troublesome potato diseases in the field, but we still have too little evidence to be certain which one. Greater experimental effort should be made to break down the barriers between nutrition and pathology.

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3. Dennis, R. W. G., and O'Brien, D. G. *Boron in agriculture.* West of Scotland Agr. Col. Resch. Bul. 5, (1937).
4. Dunklee, D. E., and Midgley, A. R. *Need and use of boron for alfalfa.* Vt. Sta. Bul. 501, (1943).
5. Heinrich, W. Abst. in Deut. landw. Presse, p. 192. Apr. 17, 1937. (Also abstracted by Dennis.)
6. Midgley, A. R. Fifty-fifth annual report. Vt. Sta. Bul. 495, p. 19, (1942).

Florida Knows How to Fertilize Citrus

(*From page* 10)

the Citrus Station staff has been able to increase production to the extent that they are now getting a box of fruit for each 0.2 pound of nitrogen applied, where they formerly obtained a box of fruit for each 0.5 pound of nitrogen. Thus, they have more than doubled the efficiency of their nitrogen through the addition of other elements in proper balance.

The spray schedule is necessarily an integral part of the Florida citrus production program, since many of the sprays supply nutrients as well as control diseases and insects. Where the recommended fertilizer practices are followed and the trees are thus kept thrifty, they have a dense, healthy foliage which is essential to high fruit production. But a dense foliage offers an ideal situation for the development of destructive insects, and hence insect control becomes more important than it is with trees in less thrifty condition.

The Citrus Station staff recommends a dormant spray, a post-bloom melanose spray, an oil spray, one additional sulphur spray, and possibly two, as needed.

The dormant spray, applied in January or February to all trees, whether or not the fruit has been harvested, includes 3 pounds of zinc sulphate, 2 gallons of liquid lime-sulphur (or its equivalent in dry lime-sulphur), and 8 pounds of wettable sulphur to the 100 gallons.

This spray furnishes zinc to the tree at a time when it gives better results than a post-bloom zinc spray, reduces rust mites before they can damage the young fruit, requires less material than a post-bloom spray, deposits no residue on the young leaves (which have not yet formed) to favor scale buildup, and spreads the spray schedule over a longer period, thus easing the pressure on equipment and labor.

About two weeks after the petals have fallen the copper and wettable sulphur spray is applied to control melanose and supply copper to the trees. This spray may be either 3-3-100 bordeaux plus 10 pounds of wettable sulphur, or proprietary copper plus wettable sulphur. The belief that no melanose is present is not justification for omitting this spray, since the nutrients contained have been of considerable value in maintaining production.

An oil spray is recommended between May 15 and August 1 for grapefruit and between June 1 and July 15 for oranges. If the trees are in good condition, this spray is quite essential, because scale-insects build up in trees with dense foliage.

If the first three sprays are applied properly, as a rule it will not be necessary to apply more sulphur before late

summer, usually late August or early September. Examinations for rust mites should be the basis for timing this spray, as well as for determining the necessity of another sulphur spray or dust before time for the dormant spray.

This fertilizer and spray schedule has rejuvenated groves that were about to vanish from malnutrition, has increased fruit production and kept it on an even keel year after year, has aided the trees to come through cold and drouth with slight damage, and has returned increased profits to growers. In fact, it has turned widespread despair into confident hope for growers on sandy citrus soils throughout Florida.

Keeping Soil Fertile in the Pecan Orchard

(*From page* 23)

contained in the rye plant are temporarily unavailable to other plants growing in the soil, and a shortage of nitrogen may develop in the soil at a critical period in the development of the pecan trees.

Pecan trees make the heaviest demands for nutrients during the latter part of April and throughout May, when rapid shoot and leaf growth is taking place, and the green-manure crop should be worked into the soil soon enough so that the nutrients released by its decomposition will be available through this period. In most years the green-manure crop should be disked into the soil by the 15th of April. Other cultivations, usually numbering from 4 to 6, should follow at fairly regular intervals for the purpose of controlling weeds which compete with the trees for moisture and nutrients, as well as to provide a good seedbed for the following winter green-manure crop. Such cultivation is essential in order to obtain the maximum results from fertilizers and green-manure crops.

Some growers may find that this much cultivation results in too much erosion, and if this does happen measures for controlling erosion should be employed, or the cultivation modified so as to protect the surface soil. Fertility cannot be maintained if surface soil is being washed away.

Winter legumes for supplying the nitrogen requirements of the orchard have been found more economical than the use of complete fertilizers; but where the grower finds it impractical to grow the legumes, a non-acid-forming fertilizer containing 4 to 6 per cent nitrogen, 8 per cent phosphoric acid, and 4 to 8 per cent potash should be used. The 6 per cent nitrogen fertilizer should be used in orchards that do not maintain good green leaf color throughout the summer, and the higher potash fertilizer should be used on the coarser sandy types of soil.

When a complete fertilizer is used, it should be applied in late February and broadcast over the entire area extending from the trunk to 6 to 8 feet beyond the spread of the branches. The amount to use depends on the age and size of the trees. In a bearing orchard about 50 pounds per tree per year should be applied. With 10 trees to the acre this amounts to 500 pounds per acre, which is considered the minimum to be used. In some orchards the rate may be increased to 800 or 1,000 pounds per acre with profit, but much depends on local conditions and the grower must rely upon his own judgment. Fertilizers used under this method should be cultivated into the soil for maximum results.

Recommended methods for the control of disease and insects by spraying and sanitation practices, as given in U. S. Department of Agriculture Farmers' Bulletin No. 1829, fit satisfactorily into the fertility program outlined. These must be used to prevent loss of the crop set as the result of the improved fertility of the soil and the increased vigor of the trees.

Bugs

(*From page* 5)

or even getting a good start at winning, the battle with the bugs.

And I don't mean tarantulas and scorpions and centipedes and vinegaroons and like delirium tremens species of our arid Southwest; because they are only meager vanguards of a mighty host of livestock and plant devourers and bacterial disease carriers lurking in billions of grass blades and weed stems, plotting new and sudden forays. Robot torpedoes and poison gas have nothing on them to task defensive skill.

However, when we measure our own lack of foresight and aggressiveness, which is bad enough, with that of many long years and countless generations previous, there is a small ray of hope. As far as I can see there wasn't much doing between the time when Moses let loose the locusts to devastate Egypt's fields and the discovery of Paris green and London purple in the late seventies or thereabouts. And those two combat weapons were just about as effective, taking in the whole force of our enemy hordes, as a muzzle-loading rifle would be today against a Panzer division.

THE insects probably exerted no nasty baneful system of propaganda like our present enemies have done, but somehow for generations, and even centuries, they lulled us into a sense that we could find a way to "live with the pests" yet. It had become so customary to divide things with the potato bugs and the grain weevils and the codling moths that we regarded it as a kind of natural toll a fellow had to pay for being a pioneer in a free country.

Somebody sold us a new idea four years ago, which has since taken hold, and we know now that we can't do business with Hitler. But too many of us still kid ourselves into thinking that maybe we can do business without fighting the corn borer and the Jap beetle. Where is the militant author who will get us lathered up on this question like the one last winter with the book on the folly of plowing?

You can lay all your plow problems end to end from now to next time and you won't even have the preface to the volume of vexations which lurk within the predatory insect world.

TO be able to know and identify one's enemies is always a strategic method of warfare. Just as kids are taught nowadays to spot the different types and models of airplanes, even as they always knew the different models of autos before we did, so should it become the objective of our agricultural world to familiarize youth with the insects in some detail.

If progress is made in that quarter in the next generation we won't have so many specimens sent to a central laboratory when it is too late to engage in control measures against them.

As for the complexities of chemical re-agents and compounds upon the life cycle of countless marauding insects, I feel we can leave that as it is now, in the skillful hands of experiment station and commercial scientists. But public interests demand that we do not continue to leave the main job of discovering and applying the remedies and controls to the manufacturers of insecticides alone.

Much hope is pinned on DDT as a specific agent for swift and wholesale attack on the waves of insect enemies marshaled against us. Before it can be widely used by every plant grower and orchardist, however, it will take further practical trials and public demonstrations no doubt, surmising that it will be available in sufficient volume when peace comes.

Our friend, the honey-bee, as well as other insects which have some benefit to mankind, will be taken into con-

sideration (like the French Underground) when powerful knock-out cure-alls are applied to vanquish the chief offenders. Such complications as this and the necessity of avoiding human poison in battling insects tend to slow up the work of extermination—if it is possible to use that word in reference to the teeming world of bugs and worms.

Breeding natural parasites to "sic onto" the worst invaders has been another fascinating line of study in bugology. Wasp parasites were used with much success in control of San Jose scale. In Ohio a few years past a terrific onslaught of Oriental fruit moth was frustrated temporarily, after it had damaged more than half of the peach trees, by artificial distribution of insect parasites. They tell me that the ordinary corn-stalk borer, larger than the insidious European prototype, has never got a bigger toe-hold among our corn fields because it has been kept down by several parasitic enemies.

That's why I felt like a secret service agent and an FBI man combined when I went into the fields last month with a state entomologist to scatter several thousand flies and wasps in moist nooks adjacent to the habitat of the corn borer. If these alien predators live up to the jaw-breaking Latin cognomens they bear, I expect to live to witness the redemption of acres of rich corn land from the worst threat our major crop has had in a century.

FINALLY, in the realm of defense from leaping and flying clouds of insect plagues, we have glimmerings today of a possible system of forecasting dovetailed to long-distance weather observations. I hear that England is busy at it, in between dodging robots. The good old Rothamsted outfit is tackling this scheme, probably with some help from American entomologists.

Forewarned is forearmed. The old way of forecasting insect invasions was by the usual regional grapevine system. One section was visited by certain unsavory and unwelcome pests and immediately spread the alarm to other growers of similar commercial crops elsewhere in the line of march.

Of course sometimes the bugs didn't live up to the advance billings and found it impossible to make the date expected of them in some other locality. That's the nature of insects anyway, you can't rely on them to do what you think they're going to do.

But this scientific weather hook-up to the bug behavior business appears to be pretty sound. At least it has been proven so far that the various weather factors in combination account for at least fifty per cent of the ups and downs in bug populations.

RIGHT now further study is being pressed rapidly on things like barometric pressure, air temperatures, rainfall, direction and force of winds, total solar radiation, degree of humidity, and amount of sunshine.

It stands to reason that up in our temperate zone the bugs stand a lot more punishment and meet a heap more discouragement than they do in the torrid sections. Just what things most hamper and limit them and which things in the weather series most favor them should prove to be a good key to unlock the probable future of specific species. If long range weather forecasting opens the way for concurrent advance predictions about insect invaders, we shall have one more weapon to help us meet our worst scourges.

But as I said before, we can't let the weather fool us or get us into a complacent mood, so as to halt our efforts to smash the crawlers before they hatch. He who depends on nature to take its course unaided in battling natural phenomena is just a dreamy old ostrich with his head in the sand.

For if we relax we'll be right back where we began in the days I spoke about. Who wants to return to the swatter, the rooster, and the kerosene can as the chief reliance against pugnacious bugs?

AVAILABLE LITERATURE

The following literature on the use of fertilizers in profitable soil and crop management is available for distribution. We shall be glad to send these upon request and in reasonable amounts as long as our supply lasts.

Circulars

Tomatoes (General)
Asparagus (General)
Vine Crops (General)
Sweet Potatoes (General)
Fertilize Potatoes for Quality and Profits (Pacific Coast)
Fertilizing Small Fruits (Pacific Coast)
Better Corn (Midwest) and (Northeast)
Fertilize Pastures for Better Livestock (Pacific Coast)
Of Course I'm Interested (Pastures, Canada)
Meet the Family (Canada)

Reprints

T-8 A Balanced Fertilizer for Bright Tobacco
N-9 Problems of Feeding Cigarleaf Tobacco
T-9 Fertilizing Potatoes in New England
F-3-40 When Fertilizing, Consider Plant-food Content of Crops
J-4-40 Potash Helps Cotton Resist Wilt, Rust, and Drought
S-5-40 What Is the Matter with Your Soil?
K-4-41 The Nutrition of Muck Crops
BB-11-41 Why Soybeans Should Be Fertilized
EE-11-41 Cane Fruit Responds to High Potash
HH-12-41 Some Newer Ideas on Orchard Fertility
B-1-42 Growing Ladino Clover in the Northeast
E-2-42 Fertilizing for More and Better Vegetables
F-2-42 Prune Trees Need Plenty of Potash
H-3-42 Legumes Are Essential to Sound Agriculture
I-3-42 High-grade Fertilizers Are More Profitable
Q-5-42 Potash Extends the Life of Clover Stands
S-6-42 A Comparison of Boron Deficiency Symptoms and Potash Leafhopper Injury on Alfalfa
T-6-42 The Fertilization of Pastures and Legumes
Y-8-42 The Southeast Can Grow Clover and Alfalfa
AA-10-42 Growing Legumes for Nitrogen
DD-10-42 Clover Pastures for the Coastal Plains
FF-11-42 Boron in Agriculture
GG-11-42 Some Experiences in Applying Fertilizer
HH-11-42 The Nutrition of the Corn Plant
II-12-42 Wartime Contribution of the American Potash Industry
JJ-12-42 The Place of Boron in Growing Truck
A-1-43 The Salt That Nearly Lost a War
C-1-43 Quality in Grasses for Pasture and Hay
F-1-43 Boron Improves Canning Beets
H-2-43 Plant Food for Peach Profits
J-2-43 Maintaining Fertility When Growing Peanuts
M-3-43 Lespedeza Is Not A Poor Land Crop
N-3-43 Boron and Potash for Alfalfa in the Northeast
P-3-43 Ohio Farmers Try Plow-Under Fertilizers
S-4-43 Plow-Sole Fertilizers Benefit Tomatoes
V-4-43 Permanent Pastures Need Help
W-4-43 The Soil Is the Basis of Farming Business
X-5-43 Malnutrition Symptoms & Plant Tissue Tests of Vegetable Crops
Y-5-43 Value & Limitations of Methods of Diagnosing Plant Nutrient Needs
AA-5-43 Can Legumes Be Over-Emphasized?
BB-6-43 Sericea Is A Good Crop
CC-6-43 Putting Fertilizer Down Puts Crops Up
EE-8-43 Pastures—That Come to Stay
FF-8-43 Potash for Citrus Crops in California
HH-8-43 More Soybeans, Please!
JJ-10-43 Soil Management for Field Beans
MM-11-43 Mississippi Farmers Improve Their Soil
NN-11-43 Maintaining Available Potassium in Soils
OO-11-43 Kudzu Conserves Southern Soils
PP-12-43 Commercial Fertilizers for Livestock Farms
QQ-12-43 Potash in War Production.
A-1-44 What's in That Fertilizer Bag?
B-1-44 Available Potash in the Surface Soils of Georgia
C-1-44 Adjustment of Agriculture to Its Environment
D-2-44 Potassium Content and Potash Requirement of Louisiana Soils
E-2-44 Plow-Sole Fertilizers Increase the Profits
F-2-44 Where Do We Stand With Fertilizers?
G-2-44 The Use of Borax in the Legume-Livestock Program of the South
H-2-44 Efficient Fertilizers for Potato Farms
I-3-44 Doubling Production by Bettering Soils
J-3-44 The Response of Various Crops to Potash Fertilization in South Carolina
K-3-44 Soil Tests Indicate Potash Levels
L-3-44 South Finds Clovers Excel in Profits
M-4-44 The Importance of Potash in Maintaining Food Production in N. C.
N-4-44 The Potash Problem in Illinois
O-4-44 Record Supplies of Fertilizer Materials Indicated for 1944-45
P-4-44 Borax Sprayed on Beets Controls Black Spot
Q-4-44 A New Approach to Extension Work
R-5-44 More About Soybean Fertilization
S-5-44 Borax Spray for Turnips
T-5-44 Southern Crops Show Need of Potash
U-5-44 The Use of Fertilizer in Maryland
V-5-44 The Seed Production of Hairy Vetch and Other Winter Cover Crops

THE AMERICAN POTASH INSTITUTE

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SLOWED HIM UP

The first officer called a deck hand to him and said—"Go below and break up that crap game."

The sailor disappeared below, and remained for the better part of an hour. Upon his return his superior officer demanded—"Did you succeed in breaking up the game?"

"Yes, sir," replied the gob.

"Well what in thunder took you so long?"

"Well sir," the sailor replied, "I had only two bits to start with."

Love is like an onion,
You taste it with delight
And when it's gone you wonder,
Whatever made you bite.

OBLIGING

"Can't I be squeezed in there somehow?" asked the young lady at the entrance door of the street car.

"If you get in I have one arm free," said Careless Clarence over the conductor's shoulder.

A transport had been sunk and several lifeboats were cruising about the surrounding waters picking up survivors. A completely bald-headed sailor popped up alongside one of the boats. One of the Irishmen manning the oars spotted him and, with a snort of rage, brought down his oar smack on the bald man's pate. "This is no time for fooling," he cried. "Go down and come up straight!"

A Negro woman in Mississippi the other day testifying in behalf of her husband admitted in court that he never hit a lick of work and that she had to support him. "Why do you live with such a trifling no-account husband?" she was asked. "Well, it is this way," she replied, "I makes de living and he makes de living worthwhile."

NAUGHTY! NAUGHTY!

Two babies in adjacent beds in the hospital. Said one to the other, "I'm a girl—what are you?"

"I'm a boy."

"But you look like a girl," she countered.

"I'm a boy—I'll show you when the nurse leaves."

Finally they were alone. He shyly lifted the covers. "See," he said, "blue booties."

Reporter: "I've got a perfect news story."

Editor: "How come? Man bite dog?"

Reporter: "No, a fire plug sprinkled one."

CARING FOR IT

Man: "They tell me Jones has a right good voice. Is he cultivating it?"

Friend: "I can't say about the cultivating but I know he irrigates it frequently."

"About this girl you want to marry; has she good connections?" asked a proud mother.

"Well, she never came apart when I was with her," replied the sailor.

Need for—

BORON IN AGRICULTURE

Authorities have recognized that the depletion of Boron in soil has been reflected in limited production and poor quality of numerous field and fruit crops.

Outstanding results have been obtained with the application of Borax in specific quantities or as part of the regular fertilizer mix, improving the quality and increasing the production of alfalfa and other legumes, table beets, sugar beets, apples, etc.

The work of the State Agricultural Stations and recommendations of the County Agents are steadily increasing the recognition of the need for Boron in agriculture. We are prepared to render every practical assistance.

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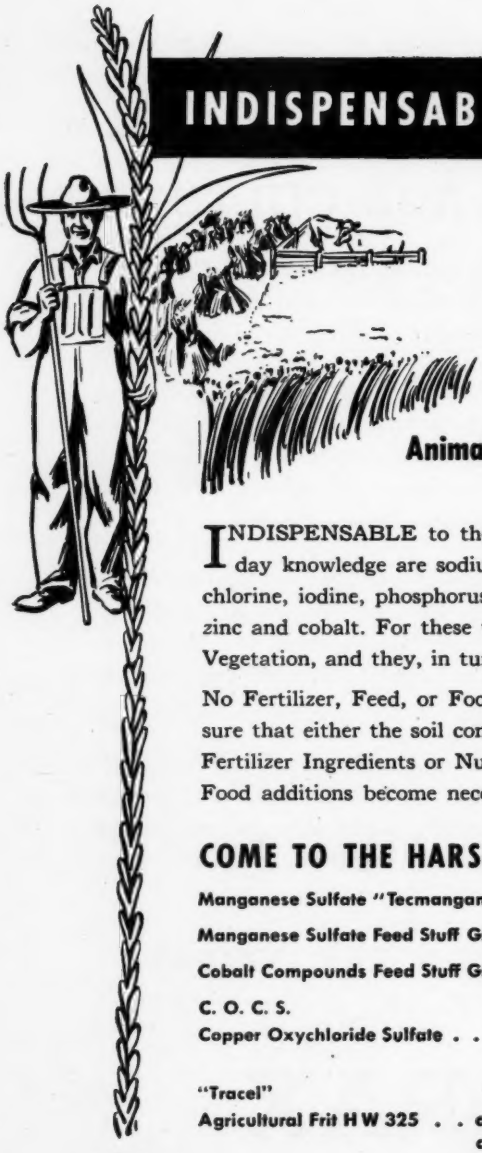

INDISPENSABLE TO ALL LIFE

37 Elements are associated in one way or another with the fabric of all life, Human, Animal, Vegetable or Micro-Organic

INDISPENSABLE to the Human diet according to present day knowledge are sodium, potassium, calcium, magnesium, chlorine, iodine, phosphorus, sulphur, iron, manganese, copper, zinc and cobalt. For these we depend on Animal Products and Vegetation, and they, in turn, depend on the soil.

No Fertilizer, Feed, or Food is complete without them. Make sure that either the soil contains them or has them supplied as Fertilizer Ingredients or Nutritional Sprays. Otherwise Feed or Food additions become necessary.

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